SERIES B (Marine) No. 42 1994

IRISH FISHERIES INVESTIGATIONS

The European Association of Fisheries Economists

J. P. Hillis
(Editor)

Proceedings of the Third Annual Conference of the European Association of Fisheries Economists

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Roinn na Mara

(Department of the Marine)

Proceedings of the Third Annual Conference of the European Association of Fisheries Economists, Dublin, Ireland, 10-12 April 1991

edited by

J. P. Hillis

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Foreword

by

J. Paul Hillis
Fisheries Research Centre, Abbotstown, Dublin 15, Ireland

The European Association of Fisheries Economists (EAFE) was founded following a meeting of interested European fisheries economists at Esbjerg in August 1988. Its first Annual Conference was a modest one held at Brussels in January 1990, while the second was held at Lisbon in March 1990. At Lisbon, the Bureau accepted an invitation to meet in Dublin in the spring of 1991, so the Third Annual Conference of EAFE was duly held in Dublin, at the Headquarters of the Geological Survey of Ireland, during the 10th to 12th April, 1991.

Three themes were selected for the Conference, (1) The Single European Market, (2) Capacity, and (3) Coastal Management. In the event, the second theme attracted the most interest, reflecting the widespread preoccupation with overfishing and the problems inherent in trying to rectify it; papers accepted included two in Section 1, thirteen in Section 2 and five in Section 3, although one (No. 16), originally submitted in Section 3, was by reason of the nature of its contents finally transferred to Section 2.

In keeping with the tradition which has arisen, the Annual Conference of EAFE was preceded by its Annual General Meeting. During the Conference, delegates were welcomed by the Minister of State at the Department of the Marine, Mr. Michael Noonan, T.D. and entertained by the Minster of the Marine, Mr. John Wilson, T.D. and the Lord Mayor of Dublin, The Right Honourable Michael Donnelly, P.C.

Thanks are due to the many colleagues in Dublin who helped to make the meeting a success, including Mr. James Carroll, Ms. Anne McDaid and Ms. Noirin O'Neill. Thanks are also due to those who have helped in production of these proceedings, notably the Series Editor, Dr. Christopher Moriarty, the anonymous referees and the typists and graphic artist who helped to render the papers in more or less uniform style.

It is hoped that these Proceedings will to some degree form a landmark in recording thought and work in fisheries economics at a critical pepoint in the evolution of European fisheries management, when recognition of the economic significance of overfishing, possible mechanisms of remedial action and the problems of implementing them were becoming more widely recognised and attracting interest on a previously unparalleled scale. Since the Conference, interest has continued to grow and show increasing signs of offering new means of managing fisheries, using economics in addition to the traditional biology to achieve results much more effective than those obtained in earlier days when biology alone was used for this purpose.

Address of welcome by Mr. Michael J. Noonan, T.D., Minister of State at the Department of the Marine

It is my great pleasure to be with you this morning to officially open your Third Annual Conference and to welcome you all to Ireland.

As Minister of State at the Irish Government Department responsible for marine matters — Roinn na Mara — I must say it is a singular honour for your Association to have chosen Dublin as your venue for this year's Conference. It coincides with the designation by the EC of Dublin as the European City of Culture in 1991 and I compliment the Association's foresight.

The Themes you have chosen for your Conference are highly topical focusing as they do on a number of contentious fishery issues currently being addressed by all members States.

Fishing capacity or to describe it more concisely, the excess fishing capacity in the Community fleet, it perhaps the single most important issue currently the subject of debate in the context of the review of the Common Fishery Policy together with total allowable catches and quota allocations.

A second Conference theme — 1992 and the Single Market with the anticipated effects on marketing and trade in fish products — is also a very live issue. The introduction of "the Single Market" will no doubt present challenges to all member states and our Irish exporters and processors are aware of its implications and the need to gear themselves for a more market-oriented trade in fishery products.

Another major Conference theme — Coastal Management including the interaction between water quality and aquaculture — should also generate a lot of interest. Certainly, a properly managed and regulated aquaculture industry can meet the highest environmental standards and avoid damage to the marine environment. By and large that is the case in Ireland. We are blessed with a relatively unpolluted coastline but there is no scope for complacency and the maintenance of water quality remains top priority.

I would like to take this opportunity to compliment the Association on its work. The promotion of co-operation among fishery economists in their research on fisheries and aquaculture can only lead to greater understanding and benefit the Community's seafish industry. It is only through such co-operation and the widest possible dissemination of information that we can help to achieve our common aims — a prosperous and developing seafish industry with all the positive spin-offs in terms of jobs and economic activity in our coastal regions. I would certainly encourage greater involvement of Community fishery economists in the scientific assessment of fisheries policy generally. Hopefully, this three-day Conference will help towards achieving these positive goals.

I hope that during your stay in Dublin you will avail of the chance to sample some of the social and cultural life of our Capital City. I understand that the Tánaiste (deputy Prime Minister) will be hosting a reception for Conference participants in Dublin Castle later this week and I trust you will avail of our hospitality. Dublin Castle dating back to 1169 should prove an interesting venue for you and particularly for those with an interest in archaeological or military history.

I will conclude by wishing your deliberations in the coming days every success and I hope this Conference will prove as enjoyable and fruitful as your previous Conferences in Brussels and Lisbon.

Thank You

Section 1

The Single European Market

Integration of the European Specialization in the World Seafood-Processing Sector

by

PATRICE GUILLOTREAU

Ecole Nationale Superieure Agronomique de Rennes (ENSAR), Rennes, France*

SYNOPSIS

The main part of this paper, after the introduction, is divided into two parts, as follows:—

Part 1: Assessment and consideration of the limitations of the international trade indicators regarding the preserved and processed fish products industry
  1.1 First assessment of the European situation
  1.2 Limitations of the use of such indicators

Part 2: Elaboration of a new index and re-evaluation of international specialization
  2.1 Presentation and significance of this new indicator
  2.2 Results

the significance of the findings is summarised and discussed in the conclusion.

INTRODUCTION

According to statistics issued by the Food and Agriculture Organization (FAO, 1990), the amount of fish caught for human consumption has undergone a continuous increase since World War II, reaching almost 70 Mt in 1988 (against 32 Mt in 1960). This is a spectacular increase; yet that of international trade in fish is even more so, since it was assessed at 50% by volume over the last decade, representing 36.5% of the world catch (live weight).

Parallel to this growth, the EC trade deficit for fish products has increased:

−2.5 billion ECU in 1985
−3.0 in 1986
−3.5 in 1987
−5.4 in 1990

Hence, the large increase in international demand does not benefit the European producers, but is profitable to the producers of Southeast Asia. In fact, imports of fish products are relatively limited geographically to three main zones, the EC, Japan and the United States. Exports are much more scattered and are undergoing profound restructuring. Beyond the natural stocks issue, factors of international specialization have to be explained in order to enhance the value issue for individual countries.

It is a matter of regret that most analyses dealing with the international specialization issue deal only with the commercial aspect of internationalization. The problem is even more pronounced in the fishing sector, where interdependence between nations is so comprehensive that it also entails other aspects such as production, finance and technology.

Over the last three decades, several phenomena have emerged which suggest that international specialization should be reexamined. First, the multinationalization of production processes means that some of the exports of one country are attributable to the subsidiaries of locally based foreign companies. In the same way, a portion of the imports of one country come from delocalized national units (e.g. imports of canned tuna in the EC). In this respect, we really should refer to territorial rather than national specialization.

Secondly, both intra-industry trade and flows of intermediate goods cannot be explained by the classical or neo-classical models of international trade. The former partly breaks away from the

*See Appendix for present address.

classical theories advocating an inter-products specialization. (Law of comparative advantage D.Ricardo 1817). The latter is attributable to the fact that countries import in order to produce. These facts require the generalization of analysis into effective terms rather than nominal or apparent terms.

This is why new models are necessary to measure specialization, taking domestic production into account. Indicators that are based on exchange flows only might lead to biassed results but care will be taken to avoid this.

Part 1 — Measurement and limitations of international trade indicators within the preserved and processed fish products sector

International specialization has been measured in 23 countries (including the EC member states) which are the most active in production and international trade of sea products. For reasons of data availability and homogeneity, the following FAO groups of products have been used:—

1. FCF: Fresh, chilled or frozen fish
2. DSS: Dried, salted or smoked fish
3. CM: Crustacean and mollusc fresh, frozen, dried, salted,...
4. FPP: Fish products and preparations, whether or not in airtight containers
5. CMP: Crustacean and mollusc products and preparations, whether or not in airtight containers
6. OIL: Oil and fats, crude or refined, of aquatic animal origin
7. MLS: Meals, solubles and similar animal foodstuffs of aquatic origin.

1.1 First assessment of the European specialization

We have been able to apply a first indicator which takes into consideration trade flows. It is inspired by the indexes elaborated by Balassa (1965) , and Grubel and Lloyd (1975) in their works on intra-industry trade. This is:—

$$Bi = 1 - \frac{Xi\text{-}Mi}{Xi+Mi} \quad \text{where } 0<Bi<+1$$

Where X = Exports
M = Imports
For a country 'i' and a given industry

The closer Bi is to 1, the more trade is intra-industry, as opposed to inter-industry. In the case of perfect identity (Bi=1), exports equal imports for similar products.

An indicator showing the contribution to the balance has been preferred to a mere ratio measuring the intensity of intra-industry trade:—

$$Aik = \frac{Xik\text{-}Mik}{1/2(XwK+MwK)} * 100 \quad \text{where } -100<Aik<+100$$

'k' is the considered sub-industry (such as FCF, DSS, CM), it represents all preserved and processed sea products, 'i' is the country and 'w' means the world. The denominator shows the international trade in the industry (the arithmetical mean has been retained because of the imperfect equality between imports and exports at this level).

Ai. can be deduced from this indicator and represents the sum of Aik per country:

$$Ai. = \frac{XiK\text{-}MiK}{1/2(XwK+MwK)} * 100$$

Table 1

Intra-Industry co-efficient of trade in seafood products (Aik), 1988

A. European Community Countries

Product	France	Italy	Spain	UK	FR Germany	Denmark	Netherlands	Belgium	Portugal	Greece	Ireland
FCF	-1.6314	-2.1999	-1.4981	-0.6987	-1.6294	-1.2110	-0.9711	-0.4175	-0.0563	-0.0919	0.4056
DSS	-0.1184	-0.8142	-0.2043	0.1125	-0.2605	0.4796	0.0799	-0.0326	-0.9563	-0.0237	0.0296
CM	-1.2406	-1.4567	-1.5011	0.0947	-0.2990	0.1984	0.1599	-0.3701	-0.0385	-0.0681	0.1303
FPP	-0.9297	-0.3316	0.1628	-0.9623	-0.0503	0.4530	-0.0059	-0.2043	0.2250	-0.0296	-0.0859
CMP	-0.4500	-0.1510	-0.1095	-0.5152	-0.2221	0.1688	0.1362	-0.1066	-0.0059	0.0622	-0.0030
OIL	-0.0030	-0.0201	-0.0237	-0.1628	-0.1244	0.0266	-0.1155	-0.0266	0.0059	0.0000	0.0000
MLS	-0.1125	-0.1007	-0.0089	-0.4323	-0.1808	0.4293	-0.1303	-0.0533	-0.0030	-0.0355	-0.0089
Total	-4.4856	-5.0742	-3.1828	-2.5640	-2.7654	2.9667	1.0955	-1.2110	-0.8290	-0.1865	0.4678

B. Non-European Community Countries

Product	Japan	USA	Canada	Norway	Thailand	Iceland	Hong Kong	Korea	China	Chile	Indonesia	USSR
FCF	-11.8816	-1.2406	2.86901	2.7032	-1.1399	1.5722	-0.0563	1.7705	0.7461	0.4796	0.2398	0.6987
DSS	-1.0126	0.2250	0.9445	0.9692	0.0415	0.7816	-0.2872	0.0977	0.0148	0.0118	0.0415	-0.0711
CM	-14.0903	-5.5959	0.8053	0.0947	1.8357	0.3198	-0.4204	1.4567	2.8631	0.1895	1.5870	0.4115
FPP	-0.9623	-1.0452	0.0533	0.2369	1.7409	0.0444	-0.0385	0.5191	0.1451	0.0918	0.0592	0.5951
CMP	-0.8290	-1.0244	0.0888	0.2546	0.6780	0.0444	-0.0799	0.5566	0.1480	0.1776	0.0178	0.1540
OIL	0.2576	0.0355	0.0000	-0.0474	0.0000	0.0918	0.0000	-0.0148	-0.0030	0.0711	0.0000	0.0355
MLS	0.0355	-0.0859	0.0148	0.0829	0.0799	0.2576	0.0000	-0.0355	-0.7609	1.3590	-0.0326	0.0118
Total	-28.483	-8.7313	4.7757	4.2931	3.2361	3.1118	-0.8823	4.3494	3.1532	2.3805	1.9127	1.8357

Source: FAO Yearbook 1990

When this equation is applied to **seafood** products, it gives, for 1988, the results shown in Tables 1a,1b and 2.

TABLE 2

Countries with positive and negative Ai 1n 1988

Rank	Countries	Ai.	Rank	Countries	Ai.
1	Canada	4,7757	1	Japan	−28,483
2	Korea	4,3494	2	USA	−8,7313
3	Norway	4,2931	3	Italy	−5,0742
4	Thailand	3,2361	4	France	−4,4856
5	China	3,1532	5	Spain	−3,1828
6	Iceland	3,1118	6	FRG	−2,7654
7	Denmark	2,9667	7	UK	−2,5640
8	Chile	2,3805	8	Belgium	−1,2110
9	Indonesia	1,9127	9	Hong-Kong	−0,8823
10	USSR	1,8357	10	Portugal	−0,8290
11	Peru	1,2169	11	Greece	−0,1865
12	Netherlands	1,0955			
13	Ireland	0,4678			

Of the eleven EEC member states in the sample, eight belong to the group of countries showing the greatest deficits. Only Denmark, the Netherlands and Ireland are in the list of countries having a positive Ai.

Japan ranks first by far on the list of deficitary countries, and if we consider Tables 1a and 1b, we see that the major part of the Japanese external deficit is attributable to two categories of products; FCF and CM.

The export supply seems to be much more scattered than demand. For example, Canada has the greatest surplus contribution to the volume of international trade, yet for fresh, chilled and frozen fish, this contribution represents only 2.9% of the international flows.

Ai. values close to 0 either indicate countries, such as Hong Kong, which practice intra-industry trade intensively or else they mask the existence of flows which are relatively minor when compared to the whole international trade, as is the case with Greece, Portugal and Ireland.

For comparison with the 1988 Ai values, those for 1970 are given in Table 3.

TABLE 3

Countries with positive and negative Ai in 1970.

Rank	Countries	Ai.	Rank	Countries	Ai.
1	Peru	10,86	1	USA	−23,20
2	Norway	7,76	2	U.K	−7,66
3	Canada	6,60	3	FRG	−6,38
4	Denmark	3,78	4	France	−5,32
5	Iceland	3,62	5	Italy	−4,74
6	USSR	2,37	6	Belgium	−2,24
7	Spain	1,57	7	Hong-Kong	−1,22
8	Japan	1,38	8	Greece	−0,29
9	Korea	1,19			
10	Chile	0,87			
11	Netherlands	0,61			
12	Thailand	0,45			
13	Portugal	0,42			
14	Indonesia	0,13			
15	Ireland	0,07			

When we compare the situations in 1988 (Table 2) and in 1970 (Table 3), the most striking point is how some Asiatic countries (particularly South Korea, Thailand and Indonesia) rose at the expense of European countries (those of EFTA and some EC members such as Spain and Portugal), and South American countries such as Peru, the specialization of which is exclusively oriented towards the fishmeal industry and which saw its relative situation deteriorate so much over the last three decades that it regressed from rank 1 to rank 11 in the international ranking of exporting countries.

The structural specialization of Portugal (marked by its involvement in a declining sector, canned fish) also accounts for the drop in its contribution to international trade. Japan fell from the status of a country with a surplus (Ai>0) in 1970 to that of the one with the greatest deficit (Ai<0) in 1988.

1.2 Limitations of the use of such indicators

When such indicators are used, it is not possible to assess specialization effective terms by, taking into account the import content of the national production and thus of re-exports.

The nature of trade — and of specialization — should be measured in terms of the dependence level of a national industry upon the intermediate goods that are needed. As far as the preserved and processed sea products sectors are concerned, these intermediate goods correspond to the blocks of frozen products which will be processed later (The processed products are here defined as as those which can be consumed at a later time thus all kinds of chilled or fresh fish, gutted fish, fresh fillet, traditionally included in the primary processing in the United Kingdom are excluded from this definition).

Thus, an intense two-way trade of products belonging to the same industry can cover many different situations, depending on the presence or absence of a locally based processing industry. Two contrasting situations can occur:—

(a) the importing country is equipped with production facilities, imported goods are used to produce goods which can be re-exported. This is the case in the former Federal Republic of Germany for which the catch level has been considerably reduced over the last 30 years, but which maintains an important processing sector. This is the result of an economic

policy choice in order to settle the resource endowment issue and the induced problem of unemployment in the north of Germany.

(b) Where this industrial potential does not exist, some imports of final goods may be re-exported. The agents in these countries are only brokers and not processors, andt it is clear that the impact on local employment is not the same. This is the case in Hong Kong, for example.

A second limit can encompass all biases inherent to the sole reference to trade flows in the computation of indicators. The importance of domestic production is therefore left aside. Similarly, the consequences of trade policies (import quotas, tariffs, subsidies for exports, etc.) partly distort the true nature of specialization.

Part 2 — Elaboration of a new index and re-evaluation of international specialization

So as to partly suppress all bias introduced by a basic consideration of trade flows or by the nominal approach of international specialization, it seems essential that domestic output be integrated into the composition of a new index.

2.1 Presentation and significance of this indicator

The weighting applied will no longer be international trade volume in the whole branch but the volume of the products group considered (FCF, DSS, CM, etc.). The indicator deriving from the preceding one will then be:

$$Eik = \frac{Qik+Xik\text{-}Mik}{Qwk+1/2(Xwk+Mwk)} * 100 \text{ where } \frac{-Mmk}{Qmk+Xmk} < Eik < +1$$

In the same way:

$$Ei. = \frac{QiK+XiK\text{-}MiK}{QwK+1/2(XwK+MwK)} * 100$$

With Q symbolizing home output consumed within national borders.

Such an indication is therefore a measure of a country's territorial contribution — in proportional terms — relative to the apparent world supply for product k. The contribution may take either a negative or a positive value.

The major concern is to evaluate home and world outputs. Reference to a world market price is deemed necessary. The average world export price may take on this role. It does not affect computation homogeneity of the numerator or denominator. Average prices obtained are as follows:

1988 k	Pw (USD/tm)
FCF	2462,7
DSS	3774,5
CM	6720,6
FPP	3069,0
CMP	6382,8
OIL	351,9
MLS	495,1
TOTAL K	2535,3

TABLE 4

Apparent National Trade Contribution within World Supply (Eik), 1988

A. European Community Countries

Product	France	Italy	Spain	UK	FR Germany	Denmark	Netherlands	Belgium	Portugal	Greece	Ireland
FCF	-0.431	-1.231	0.990	0.579	-0.360	1.923	1.571	-0.239	0.225	-0.037	0.940
DSS	0.065	-1.120	0.141	0.742	-0.142	1.192	0.594	0.003	-1.361	0.112	0.142
CM	-1.624	-1.364	0.292	1.099	-0.396	1.732	0.215	-0.347	0.010	0.103	0.305
FPP	0.019	1.079	2.032	-1.398	1.713	1.812	0.256	-0.167	1.059	-0.031	0.075
CMP	-2.899	-0.571	1.509	-3.546	-0.787	4.140	1.952	-0.609	0.031	0.688	-0.013
OIL	0.035	-0.799	-0.598	-6.145	-4.647	5.296	-4.583	-1.058	0.319	0.000	0.186
MLS	-0.558	-0.630	0.739	-2.385	-0.958	6.148	-0.866	-0.343	0.049	-0.236	-0.020
Total	-0.601	-0.820	0.861	0.075	-0.069	1.973	0.795	-0.229	0.013	0.039	0.453

B. Non - European Community Countries

Product	Japan	USA	Canada	Norway	Thailand	Iceland	Hong Kong	Korea	China	Chile	Indonesia	USSR
FCF	10.768	1.484	3.689	3.322	0.478	1.999	0.059	7.193	2.758	0.743	0.247	16.970
DSS	14.055	0.648	2.561	2.753	14.423	2.682	-0.377	0.747	23.459	0.067	11.640	10.856
CM	-9.233	0.632	2.276	0.530	8.463	0.785	-0.351	3.038	7.903	0.657	3.449	0.555
FPP	23.553	3.681	0.789	1.150	6.980	0.110	-0.062	3.640	0.517	1.111	0.198	20.498
CMP	2.086	1.525	0.715	1.916	18.533	0.497	-0.531	6.994	2.911	2.503	0.513	1.493
OIL	30.312	5.625	0.915	1.751	0.000	7.548	0.000	-0.543	-0.118	10.593	0.136	6.060
MLS	10.909	3.204	0.772	2.482	2.766	3.582	0.064	0.467	-4.569	19.864	-0.205	7.569
Total	9.263	1.610	2.498	2.228	6.394	1.628	-0.143	4.315	6.873	1.556	2.932	12.150

Source: FAO Yearbook 1990

2.2 Main results

See Table 4 (a and b) and 5

This second evaluation yields conclusions apparently contradictory to those computations contrasting with those obtained during the previous computations. For example, a comparison of Tables 3 and 5 indicates that the USSR remains a strong producing country, even though it ranks tenth for export performances.

TABLE 5

Countries with positive and negative Ei in 1988

Rank	Countries	Ei.	Rank	Countries	Ei.	Rank	Countries	Ei.
1	USSR	12,15	10	ICELAND	1,63	1	ITALY	−0,82
2	JAPAN	9,26	11	USA	1,61	2	FRANCE	−0,60
3	CHINA	6,87	12	CHILE	1,56	3	BELGIUM	−0,23
4	THAILAND	6,39	13	SPAIN	0,86	4	HG-KONG	−0,14
5	KOREA	4,32	14	NETHERL.	0,80	5	FRG	−0,07
6	INDONESIA	2,93	15	IRELAND	0,45			
7	CANADA	2,50	16	UNITED K.	0,08			
8	NORWAY	2,23	17	GREECE	0,04			
9	DENMARK	1,97	18	PORTUGAL	0,01			

The excellent specialization of the Asian Countries is made evident here by the fact that five of these countries are placed among the six best producers/exporters in the world. The example of Japan especially reminds us that we should not confuse disengagement for exports and the keeping of a production tool with domestic vocation, generating major external effects (shipbuilding, packaging industry).

In contrast, countries such as France and Italy are experiencing a relatively worrying situation when compared to their European neighbours. Poor results in external trade do not mask the existence of national prosperous industries! The contribution of France to world supply is positive only for three groups of products (DSS, FPP, OIL), none of which is among the most dynamic in terms of either growth or income-generation.

Respective results from Germany and Hong Kong are illustrative of the comments in paragraph 1.2. The German contribution to world supply is higher than that of Hong Kong and generates more local employment opportunities because of the presence of a domestic processing industry in this European country.

Tables 4a and 4b also enhance the geographical concentration of the various supplies. As an example, three-quarters of the apparent world supply in dried, salted or smoked fish emanates from five countries, all but part of one of them in Asia, Japan, Thailand, China, Indonesia and the USSR. World supply for fresh, chilled or frozen fish is more scattered since the 18 countries included in the sample and contributing positively to the supply achieve only 55.8% of its estimated value.

CONCLUSION

The introduction of non-exported home output in the computation of world specialization indicators sheds new light on the situation. Most of all, its worth is to avoid confusing export strategy-external involvement or not — and processing tool structuring.

Globally, structural specialization in the European Community is not good, given the extremely sharp growth in world — and European — demand for products of which production is poorly represented throughout Europe, notably crustaceans and molluscs. The share of the mollusc and crustacean trade — mainly cephalopods and shrimps, the hallmark of Asian countries — accounts for one-third in value of the world trade for fish products. Poor EC external results are therefore to be attributed to a large excess in domestic demand, as compared to domestic supply, and to the European firms' uncompetitiveness.

However, weak performances should not overshadow the value of the European processing industry and the necessity to support and develop this processing tool, which is truly the valuable logical extension of the catching activity.

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Import Determination for Groundfish in France

by

CHRIS IOANNIDIS
University of Wales, College of Cardiff, Cardiff, UK

and

FREDERIC LANTZ
IFREMER, Issy les Moulineaux, France

1. Introduction

1.1 In this paper were examine the determination of imports for selected groundfish in France over the late 80's. France has the highest consumption of 'seafood' per head within the EC and is the biggest European importer of 'seafood'.

The trade deficit in seafood is a important item on the liability side of the French Balance of Payments accounts. The deficit has been rising steadily since the mid 70's, as domestic consumption kept growing whilst domestic landings were shrinking severely. By 1989 France was a net importer of around FF 14bn worth seafood products.

Salmon, tuna and crustaceans form the most important species groups in the imports. Groundfish are the next important group of species. In this group cod is the most significant and it now accounts for 11.5% of the sea product deficit. The value of cod imports rose, in real terms, for FF792m in 1982 to FF1.062bn in 1989.

The significance of cod cannot be underestimated in terms of domestic production. The value of fresh cod landings was second only to tuna landings between 1983 and 1988. Since then the sharp decrease in domestic landings has reduced its importance in value terms to the 5th place of domestic production.

The foreign deficit in sole stood at a modest FF64m in 1989 but the value of fresh sole landings places them third in terms of the value of domestic production. Furthermore France is the largest European exported and importer in this species, with imports standing at FF101m and exports of FF136m.

1.2 *European trade in cod and sole.*
Cod is internationally widely traded species and its importance has increased markedly during the 80's. The species is traded internationally in fresh and frozen form but more frequently in the form of fillets.

Cod (fresh and frozen) and fresh sole are probably the two most important species and their consumption has been steadily increasing despite the fact that their 'real price' has shown strong upward trend.

The behaviour of French consumers in choosing between sources of animal protein in the food-budget has been examined by Lantz and Ioannidis (In the press) for the period 1960-1989 and it was found that 'seafood products' were price inelastic compared to all other sources of 'animal protein'; their share in the food budget increased despite the adverse relative price change. To satisfy the ever growing domestic demand, in the face of reduction in landings and capacity, imports have played a vital role in keeping the domestic processing sector buoyant and have slowed the price increase.

During the 80's cod imports fresh or frozen fillets have exceeded domestic production by a factor of approximately 3 in terms of both value and quantity despite a modest increase in domestic landings over the last 5 years. Within imports, frozen fillets are claiming an ever increasing share at the expense of fresh fish.

In France imports of cod fillets (frozen) account for over 80% of total cod imports, excluding dried and salted cod. In European terms, France is the second most important importer of cod and obtains her supplies principally from other community countries notably Denmark (32% of imports) and Germany (21%). The proportion of cod imports in France which originates from community countries is 75% for fresh, frozen and cod fillets, and the non-EC supply of dried and salted cod originates in Iceland and Norway which account for over 80% of imports.

The European sole market, with FF13 bn transactions in 1988 is a less important market than that of cod, and is distinguished by the great volume of inter-European transactions. France represents 17% of the market, the third most important country after Italy (33%) and Spain (19%). The main foreign suppliers to France, are the Netherlands , Belgium and in general North Sea coastal countries. At the same time France's main clients are the Mediterranean countries, Italy and Spain.

The overall share of cod imports on total supply has shown a slight tendency to decrease but nevertheless the degree of import penetration is very high.

TABLE 1

Annual Average Cod Domestic Production and Imports 1985m1 1989:7 in 'real terms'

	Domestic production(t)	Imports quantity (t)	Imports value (FF)
1985	1,270	4,733	27,814
1986	1,692	4,307	28,110
1987	1,732	5,431	35,553
1988	2,056	6,135	35,949
1989	1,896	8,419	44,357

(Import quantity in fresh fish equivalent)

Over the same period real prices have been rising steadily with import prices rising somewhat faster than domestic ones.

TABLE 2

Real prices of Domestic Landings and Cod Imports

	Domestic Prices (fresh fish)	Import Prices (fresh fish)	Frozen Fillets
1985	7.37	8.23	11.84
1986	6.89	9.30	12.84
1987	6.92	7.70	14.41
1988	6.65	7.53	12.54
1989	6.65	6.60	11.40

The degree of import penetration which is given by the ratio Imports (Imports + Domestic Production) has been evolving as follows:

TABLE 3

Import Penetration Ration for Cod

	Import Penetration Ration in Fresh Fish Equivalent	
	Value	Quantity
1985	.748	.784
1986	.698	.704
1987	.729	.739
1988	.713	.736
1989	.780	.816

The market for sole in France both at landings and wholesale level has been examined by Ioannidis and Lantz (In the press). This species is consumed almost exclusively fresh and unfilleted thus there is no value added due to processing, to speak of. The species is one of the most valuable and it accounts for 8.5% of of total landings in value terms whilst it contributes only 1.6% of total weight. Its price along with most other species has risen over the period by % in real terms. Imports account for almost half of total demand and their share is on an upward trend.

TABLE 4

Domestic Production and Imports of Fresh Sole 1985 1988, in real terms

	Domestic Landings (t)	Imports Quantity (t)	Imports Value (ff)	Imports Penetration Ratio (quantity)
1985	278,904	100,284	33.21	.377
1986	157,827	257,321	42.83	.657
1987	160,379	179,665	44.79	.534
1988	108,386	281,409	39.04	.736

The import series for both species appear to be very volatile and they are characterised by strong seasonality, but there are definite trends in their evolution over the period 1985-1987m7. On one hand the underlying trend for imports of cod exhibits a mild downward tendency (whose significance depends crucially on the type of the adopted seasonal adjustment). On the other hand sole imports have a strong upward trend for the period 1985, 1988. Imports of sea products into France are subject to a tax regime in accordance with EC guidelines on such protections and measures.

TARIFF SYSTEM

The European Community applies a common custom tariff (TDC-Tariff Douanier Commun) for all the products which originate outside the EC. This is an ad valorem system, Two kinds of taxes are generally in force. The most commonly utilised "conventional taxes", and the "autonomous taxes". The "autonomous" taxes apply when they are inferior to the conventional.

Table 5 presents the rates of import tax for cod and sole. They range between 12 and 18% depending on the nature of the product. However it must be noted that the EC applies preferential rates to Iceland, Norway and the Faroe Islands. For the species in question the rate is 3.7% for wholefish originating in Iceland and 0% and 3% for frozen fillets from Iceland and Norway and for the Faroe Islands respectively.

Neither Denmark nor the United Kingdom impose any tax on imports of frozen fillets from these sources.

TABLE 5

Import Taxes (at 1.1.89)

	Autonomous	Conventional
Sole	15%	15%
Cod		12%(1)
(Whole Fish)	15%	15%
Cod (fillets)	18%	18%
Cod (Frozen fillets)	18%	12%(1)
Cod (dried/salted)	13%	13%

(1) The tax of 12% is applied to the species Gadus morhua* otherwise 15%.
(2) The tariff is reduced to 8% for the species Gadus morhua*.

The EC trade policy in cod products has two elements. First there is an overall quota agreement over which lower tariffs operate, The imports are the distributed to the member states according to the average consumption of the last three years, and what is left is then allocated according to "needs" as they occur. Once this quota has been exceeded normal import taxes apply.

Furthermore the EC has defined the reference price which acts as floor for the price of imports. These minimum prices correspond to the withdrawal prices of fresh fish, adjusted for the value added element in the filleting and freezing process.

If during any three day period the import price is lower than the reference price then the autonomous taxes are applied.

In criticising the European policy of erection of trade barriers, Freeze (1990) cities the very low taxes which other members of GATT apply to demand fish. For example the US imposes a 1.875 cents per lb. on imports originating from GATT states. Non EC-member states in Europe find that the community markets are easily accessible to them as the main consumers, France, UK, Denmark etc. impose little or no taxes; however non-European countries, e.g. Canada, which are able to supply the species, find their access to the European market very difficult.

The analysis of the competitive process in the market must not be limited to he examination of the tariff policy. It must take into account (a) the non-tariff barriers (OECD, 1985 and (b) the international specialisation in each segment of the industry , CEPII (1986).

***The vast majority of cod traded in Europe are, in fact, of the species** *Gadus morhua.*

The imposition of quotas and the evolution of productivity and competitive advantage in the processing industry in France and its trading partners, will be of great importance for the profitability and thus the long-run survival of both the fishing and processing sectors.

To examine to what extent are the recent trends in French import demand for cod and sole due to market growth and/or competitive pricing by the exporting countries in the following section we present two models of import determination which we apply to the cases of the two species.

2. Allocating Domestic Demand

2.1 *A Simple model*

Customarily aggregate import function take the form:

$$im = f(f, rp, s, z) \tag{1}$$

where im is real imports (for the economy, or the sector), d is some measure of demand, rp is a ratio of the price of the imported goods relative to those produced domestically, s denotes some 'trend/technological' variable and finally z can be considered to represent other variable which might enter the model. The underlying economic rationale behind this structure is the assumption of imperfectly competitive markets at home and abroad, which allow sufficient product differentiation to exist between domestic and foreign producers. In this case of fish this might be reflected in differences in the freshness of the landings and/or the size distribution. In the case of processed fish, where value added has been incorporated in the product, competitive advantages may accrue to exporters due to lower per unit price either due to lower costs, high productivity or favourable exchange rate movements. It is questionable whether one can safely assume that total demand, d, is independent of this choice, but nevertheless this a commonly adopted convention.

The functional form of equation (1) is normally assumed to be log-linear, so that the estimated coefficients can be interpreted as elasticities, which remain constant independently of the level of import demand, The dynamic version of the equation is motivated by the adoption of a partial adjustment model. Purchasers, in this case the distributive and processing industry, find it costly to totally adjust their capacity as input prices and final demand change from period to period.

In the presence of costly capacity adjustment the processing industry will require from its suppliers not only competitive process but also regularity of supplies, to the extent that there some substitution between the different species or forms of the same species, the industry will try to reduce uncertainty in supplies by enlarging the number of suppliers.

Thus the more uncertain are domestic supplies the more likely it is for the domestic industry to seek suppliers abroad, in order to achieve an uninterrupted level of production. To capture such a phenomenon we have included in (1) terms which reflect the uncertainty of domestic supplies, in terms of the variance if the forecasting errors of domestic prices and landings. These are denoted as 'varp' and 'varq' respectively.

In the light of the above discussion we have estimated the dynamic versions of the log-linear version of (1) with the addition of the extra variable, ignoring the constant term and seasonal adjustment:

$$in\ (im)_t = al*In(d)_t + 2*in(im)_t - 1 + a3*In(rp)_t + a4*varq_t + varp_t t \tag{2}$$

the impact relative price elasticity is given is given by a3 and the long-run elasticity is equal to

$$n_{rp} = \frac{a3}{1\text{-}a2}$$

In the estimation we have approximated d by the index of real retail sales, rp is the price ratio in constant FF of imports, and varq and varp are computed as the squared errors from the ARIMA forecasting equations for domestic landings and prices.

2.2 *Preliminary Results*

The frozen cod fillet equation was estimated using a general dynamic specification in the spirit of (2). After some testing, the preferred method of seasonal adjustment was the inclusion of seasonal dummies. The equation was estimated in levels in terms of fresh fish equivalent (the concession factor used was 2.84) and its own real price was included in the equation along with the real price of domestic landings. The parsimonious specification finally adopted yielded the following results, for the period 1985 M5 to 1989 M7.

TABLE 6

Imported Cod Fillets: 1985:M5-1989:M7

	$LQMF4_{t-1}$	$LRPM4_t$	$LVRS_t$	$VARQ_{t-1}$
	.37 (2.74)	−.766 (−2.33)	3.12 (3.05)	2.92 (2.24)
R^2 = .747	h = −.56	LM(4) = 7.4	ARCH	(1).217
CHOW (mid point) = .945	JB = 3.37			

[Contract and dummy variable are not reported] (t-stat)

LQMF4 = log (imported cod fillets)
LRPM4 = log (price of imported, frozen cod fillets/consumer price index)
LVRS = log (retail sales)
VARQ = variance of the forecast error for domestic landings.
h = Durbin's alternative statistic of AR(1)
LM (4) = Lagrange Multiplier test for Ar (4)
JB = Jarque-Beta test for normality X^2_2
ARCH = Auto regressive conditional heteroscedasticity
CHOW = Test for Structural Stability

The equation has high explanatory power and is well specified. No structural instability was detected and its predictive power is satisfactory. The estimated coefficients have the expected signs and are all significant at the 5% level. The interpretation of the coefficient associated with the volume of retail sales as "income elasticity" is of course problematic as retail sales are merely a proxy for "household income allocated to food", but both its size and sign are in accordance with our expectations. The short run price elasticity is .72 and the long run is 1.15.

We now turn to the fresh-cod import equation. In this case the method of seasonal adjustment used is a 12th order autoregressive polynomial (terms 2 to 11 have been set to zero). Unless there are substantial differences in quality and size distribution domestic and imported cod could be treated as almost perfect substitutes. Due to this close association the real price of domestic landings was included in the equation and to avoid simultaneous equation bias the variable was instrumented. The estimated coefficients testify to the assertion that no substantial quality differences exist between imported and domestic fresh cod as the coefficients associated with own and domestic prices are equal and of opposite signs. No 'retail sales' effect was found to be significant but neither 'varp' nor 'varq' terms contributed to the regression, again as in the previous case they both entered with the at priori signs. The estimated price elastics show that whilst in the short-run the elasticity is not different from unity, in the long run, given the strong (perfect) substitutability of domestic and foreign landings, the elasticity increases to a value of 5.

TABLE 7

Imported Fresh Cod. 1986M1 — 1989M7
(Instrumental Variables)

$LQMF1_{t-12}$	$LQMF1_{T-1}$	$LRPM1_t$	$LRPM_t$	$VARQ_{t-3}$
5.2 (4.)	.27 (9.95)	−1.02 (−4.04)	.96 (2.45)	.0000035 (1.24)
R^2 = .72	h = .63	LM(4) = 69	ARCH(1) = .78	
[Constant not reported]	CHOW(Midpoint) = 1.35		JB = 2.89	

LQMF1 = log (imported fresh cod)
LRPM1 = log (price of imported cod/consumer price index)
LRPM = log (price of domestic landings/consumer price index)
" = indicates that the variable has been instrumented
VARQ = variance of forecast error for domestic landings.
Q(18) = Lying-box statistic

The same specification was adopted to model fresh sole imports, using the prices quoted at Rungis for imported and domestic fresh sole. The equation was estimated for the period 1985m1-1988 m12 and it was estimated in levels; seasonal dummies were found to be superior to other forms of seasonal adjustment. What is rather puzzling is that no contemporaneous variable was found to be significant in the estimated equation. The relative price effect enters the equations with a lag and its magnitude is modest in the short run. The long-run elasticity of 4.7 is not dissimilar to the one found for fresh cod. The equations is well specified as the diagnostic tests indicate. Both the uncertainly terms make a useful contribution to the explanatory power of the equation, especially price uncertainty. As fresh sole is consumed unprocessed, local demand fluctuations at the landing port result in wholesale price variations and induce substitution to a less volatile imported supply which can be contracted in advance. Our results here confirm our previous findings (Ioannidis and Lantz, 1990b)

TABLE 8

Imported Fresh Sole 1985:M12

	$LSOLi_{t-1}$	$LRPWS_{t-1}$	$VARQS_{t-1}$	$VARPS_{t-1}$
	.84 (12.04)	−.66 (−1.05)	1.00 (1.59)	6.15 (2.02)
R2 = .81	h = .83	LM(4) = 2.75	ARCH(1) = .69	
CHOW (6)-1.55		JB = 1.6		

Constant and seasonal dummies not reported

LSOLi = log (imported fresh sole)
LRPWS = log (price of imported fresh sole at Rungis/price of domestic sole at Rungis)
VARQS = variance of the forecast error for domestic landings
VARPS = variance of the forecast error for the price of domestic landings

These preliminary results indicate that relative proves are important determinants of import demand for both cod and sole. The influence of total demand was shown to be strong in the case of frozen cod fillets and indirectly in the case of fresh sole. However as imported fresh cod is such a close substitute for domestic cod, imports keep the price of domestic landings close to the international level. The EC policy of taxing landings of cod by non-EC vessels results in the imposition of import quotas and the operational use of the reference price, causing a loss to the French consumer and a subsidy to both French and non-EC fishermen. This policy along with the low price elasticity of consumption for seafood products provides an undesirable incentive structure to both domestic and non-EC fishermen as it reduces the incentive to cut costs and increase economic efficiency. Our attempt to introduce the unpredictability of domestic landings and prices as contributor to the rise of imports was partially successful and seems a promising modelling device. Further investigation is required to examine the export pricing policy of the non-EC countries as a function of domestic costs and international prices, (Cuthbertson 1989). Finally a more in-depth investigation of the processing industry is required where frozen fillets are treated as an input in the production process of fish products, if one is to obtain a thorough understanding of the costs of adjustment and the significance of stability of supplies of the raw material.

3. Model of Import Penetration

3.1 *Relative Prices and Competitive Advantage*

In the first section of this paper we have mentioned that differences in size and freshness may be important enough to differentiate fish landings into distinct categories in the case of fresh fish. Further cost advantages enjoyed by one trading partner in the processing stage, will result in increased market share at the expense of the domestic producers.

TABLE 9

Short and Long-Run Price Elasticitites of Cod and Sole Imports

	SHORT-RUN	LONG-RUN
Fresh Cod	1.02	4.85
Frozen Fillets	.766	3.33
Fresh Sole	.66	4.72

To model such a situation consider the following simplified model of import demand suggested by Bismout and Martins (1986).

Under some rather mild assumptions one can write the cost function which domestic processors minimise for a given level of demand as:

$$c = (P_{d1} *d1p_{im} *im)-p*(f(de,im)) \tag{3}$$

where c is total cost, p is the price of the final product (f(.) denotes the firm's production function, whose two factor are assumed to be dl (domestic landings) and im(imports). The firm is facing pragmatic factor prices Pdl and pim .

Let the functional form of the production function be CES

$$f(.) = [a^* dl\text{-}b+(1\text{-}a)im\text{-}b) \text{-}(1/b) \tag{4}$$

then the first order conditions for cost ministration are given as:

$$im/d1=[a/(1\text{-}a))*(p^{im}/Pdl)]^{(-1/(1+b))} \tag{5}$$

taking logarithms and adopting an obvious shorthand notation we have

$$z = A - S^*p \tag{6}$$

Where A = S*ln((1-a)/a), S is the elasticity of substitution between domestic and foreign landings; in terms of the model parameters it is given by S = (b/(1+b)). P denotes the log ratio of prices. Equation (6) can be also expressed in value terms as

$$v = A+(1\text{-}S)p \tag{7}$$

The importance of the elasticity of substitution is now clear. We can identify three cases. 1) If S=1 the market share of imports is independent of relative prices; 2) A value of S>1 implies that if domestic prices were to rise (*ceteris paribus*) then domestic producers will lose market share; and finally, 3) if 0<S<1, domestic price rises will result in increased domestic market share as the fall in demand will not compensate for the rise in domestic prices, Therefore in the value of S we have a measure of the competitiveness constraint faced by domestic producers. There is also a unique relationship between the price elasticity of demand for domestic landings and imports and the elasticity of substitution, which is given as

$$e_{dl,p} = S^*(im/f(.)) \tag{8}$$

$$e_{i,m,p,} = S(dl/f(.)) \tag{9}$$

It is a relative simple matter to augment the model in order to subdivide imports of a particular product by their country of origin, as a function of relative import prices.

3.2 *Empirical Implementation*

The simple models given by equations (6) and (7) may now be estimated and a conclusion can be drawn regarding the presence of competitive pressures on domestic producers. The equations can be taken to represent the equilibrium long-run market division between domestic and foreign producers in the short run. As they both face semi-fixed factors of production with increasing marginal costs, (Lawrence, 1990) a Partial Adjustment Model will be used

$$D\ z_t = P(zt\text{-}z_{t-1})) \tag{10}$$

Where D is the first order difference operator, P is the speed of adjustment, and z* is given by an equation (6). As previously we can include terms for uncertainty, relative market size, etc.

Substituting into (10) we obtain the dynamic version of equation (6)

$$Zt = t^*A\text{-}(1\text{-}S)^*\ pt + (1 - t)^*Zt\ \text{-}1$$

3.3 *Results*

By transforming frozen fillets to fresh fish equivalent and then constructing the weighed import price index in real terms we computed z and p for cod. For sole we have used the Rungis quoted prices to construct the relevant relative price variable. All the variables were seasonally adjusted by the use of dummy variables, and the adoption of such a procedure makes the interpretation of the coefficient associated with the constant term impossible.

The results of the preferred equations are presented in Table 10 and 11 for cod and sole respectively.

TABLE 10

Division of total Domestic demand for Cod

	LRLP	LVC$_{t-1}$ (Quantity)
	.846	.55
	(-2.75)	(4.8)
	LRLP$_t$	LVV$_{t-1}$
	−.24	.58 (value ratio)
	(−1.25)	(4.7)

(Constants not reported, (t-stat)).

R2 = .43	h = −.55	LM(4) = 3.17	ARCH(1) = .21	CHOW = 1.73
R2 = .34	h = −.19	LM(4) = 3.47	ARCH(1) = .07	CHOW = 1.0

LRLP = log ('weighted' imports, price of cod/proce of domestic landings of cod).

LVC = log (import volume of cod/domestic landings of cod).

The results forming the estimated equations are somewhat ambiguous as the estimate of the elasticity of substitution price depends on the form of the specification adopted. The estimate of S from the quantity ration equation is less than unity but a t-test on the Null hypothesis that S=0 suggests that the Ho cannot be rejected. The conclusions of the test are supported by the evidence presented in the value ration equation, where the estimated coefficient (1-S) is no significantly different from zero).

The long-run estimate of the elasticity of substitution is in excess of unity, indicative of the existence of strong competitive pressures on domestic producers. The expansion of the market will tend to reduce their share as imports become more dominant.

Polices which maintain high domestic prices are therefore anti-conservationist as they encourage the expenditure of higher fishing effort by the domestic producers. The solution to the recent problems of the rapid depletion of fish stocks in the North Sea is to call for the relaxation of the protectionist regime for cod currently in place. New suppliers, especially Canada, should be allowed free access to the European market lowering the price to the consumer and reducing domestic effort,

The indication for the improvement of the situation regarding fresh sole is not dissimilar to that for cod as result of Table 11 indicates.

TABLE 11

Division of total demand for fresh sole.

	$LRPW_t$	LVQ_{t-1} (quantity ratio)		
	−.59	.65		
	(−1.17)	(6.06)		
(Constant not reported)	(t-stat)			
R2 = .47	h = .72	LM(4) = 6.94	CHOW = .09	JB = 6.74

The long run elasticity of substitution is greater than unity, and is not far from our estimate for cod, as it stands at 1.68, indicating competitive pressures from abroad.

4. Conclusions

In this study we have developed two models of import determination for groundfish, namely cod and sole in France for the period 1985-1989.

The French market relies heavily on imports to satisfy domestic demand and this tendency shows no sign of abating, for either of the species we have examined, The situation is more clearly defined in the case of fresh sole were the import penetration ratio rose form .377 to .736 within the last 4 years., Real sole prices have continued to rise and they stood at 20% above their 1985 level by the end of 1988. Cod prices have shown considerable stability with a modest tendency ot fall over the past five years. The estimated dynamic equations performed well and have shown that relative prices are of importance especially in the case of cod, It seems to us that, imports of fresh cod quality adjusted are an almost perfect substitute for domestic landings, Uncertainty about domestic production was also a factor in the increase for both cod and sole imports. Domestic demand pressures exercise a powerful influence and this trend is expected to continue.

In Part Three of this study we have developed a model of import penetration in order to examine the likely path of imports compared to domestic production when relative prices alter, Our preliminary econometric results imply that given the structure of the market for fish in France, domestic price increases are likely to result in domestic producers capturing a smaller share of the market in value terms. In the presence of policies aiming to conserve fish stocks, the imposition of protectionist measures which keep domestic prices artificially high is contradictory. These policies result in

overcapitalisation and inefficiency as domestic producers increase capacity to exploit the extra profit opportunities. A policy of free-trade in all fish products seems the most logical. With efficient non-EC producers (in terms of cost and/or resource availability) having full access to the EC markets the result will be a substantial reduction of domestic prices. In conjunction with the already enforced quota policy there will be gradual reduction in domestic capacity and a further expansion of the market for seafood products.

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Section 2

Capacity

Review of North Sea Fisheries Management in the 1980s

by

JAN WILLEM DE WILDE

Agricultural Economics Research Institute (LEI), The Hague, Netherlands

ABSTRACT

Recommended Total Allowable Catches (TACs), agreed TACs and actual catches of cod, haddock, whiting, sole and plaice in the North Sea between 1981 and 1990 are compared. Conclusions are drawn on the adherence of fisheries administrators to biological advice and of fishermen to agreed TACs.

From average fishing mortalities by year, fishing mortality indices are derived for catches as well as for recommended and agreed TACs. These are used as indices of fishing effort. Their relative courses lead to some reflections and conclusions on the soundness of the present fisheries management system.

INTRODUCTION

This study was started under the assumption that EC fisheries politicians and administrators tend to diverge from biological advice in fixing Total Allowable Catches (TACs), more or less undermining a basically sound management system. This might mean that they will diverge from independent (scientific) advice given in other fisheries management systems, with similar disappointing results.

In order to support this thesis, data on the main North Sea demersal species — cod, haddock, whiting, plaice and sole — were taken from the October-November reports of the Advisory Committee on Fishery Management (ACFM) and were analyzed. These reports contain the biological advice to the North-East Atlantic Fisheries Commission for managing most of the fisheries in the region. They give a series of data on recommended and agreed TACs, actual catches as estimated by working groups, and assessments of (spawning) stock biomass, recruitment and average fishing mortality. These data, covering the period 1981 to 1991, are reproduced in the Appendix. In the tables. the assumptions about the 1990 fishing mortality and consequent catches in 1990 and the spawning stock biomass (SSB) in 1991 — forming the basis for the biological advice for 1991 — have been included. The assumptive nature of such data on the present (and the coming) year is crucial for the quality of the biological advice, as will be discussed later on.

The methods of analysis were very simple: a graphic survey, the use of basic knowledge of fisheries biology, and simple statistical calculus.

TACS RECOMMENDED AND AGREED

When making graphs of recommended and agreed TACs by species, it soon became apparent that our view had been biased by our background. In Dutch fisheries flatfish like sole and plaice are the most important species. Particularly with these species the TAC's agreed upon were most of the time significantly higher than the TAC's advised, as show the figures 1 and 2.

The recommended TAC for sole averaged nearly 15,000 t from 1981 to 1990, whereas from 1982 up to '86 the agreed TAC's were 5,000 t and more above recommended levels. Only over the last three years (apart from 1981) the decision makers have completely adhered to the advice. This may have been made easier by the advent of a very strong year class 1987, following three successive severe winters. This was specifically protected in '89, by the prohibition of beamtrawling with vessels over 1800 hp south of 55°N and subsequently gave rise to very significant increases in TAC levels.

Differences between recommended and agreed TACs of plaice started after agreement on the Common Fisheries Policy (CFP) was reached in 1983. The largest difference occurred in 1985 when instead of a recommended decrease to 130,000 tons the Fisheries Council agreed on a rise in TAC to 200,000 tons. After that, the agreed and recommended TACs came closer together and subsequently, differences have been very small. In this case the reason behind the differences was rather clear: fixing the TAC substantially above the recommended level enabled the politicians to bring the Dutch quota more in line with its fishing capacity, without endangering the size of the stock.

B

Sole North Sea

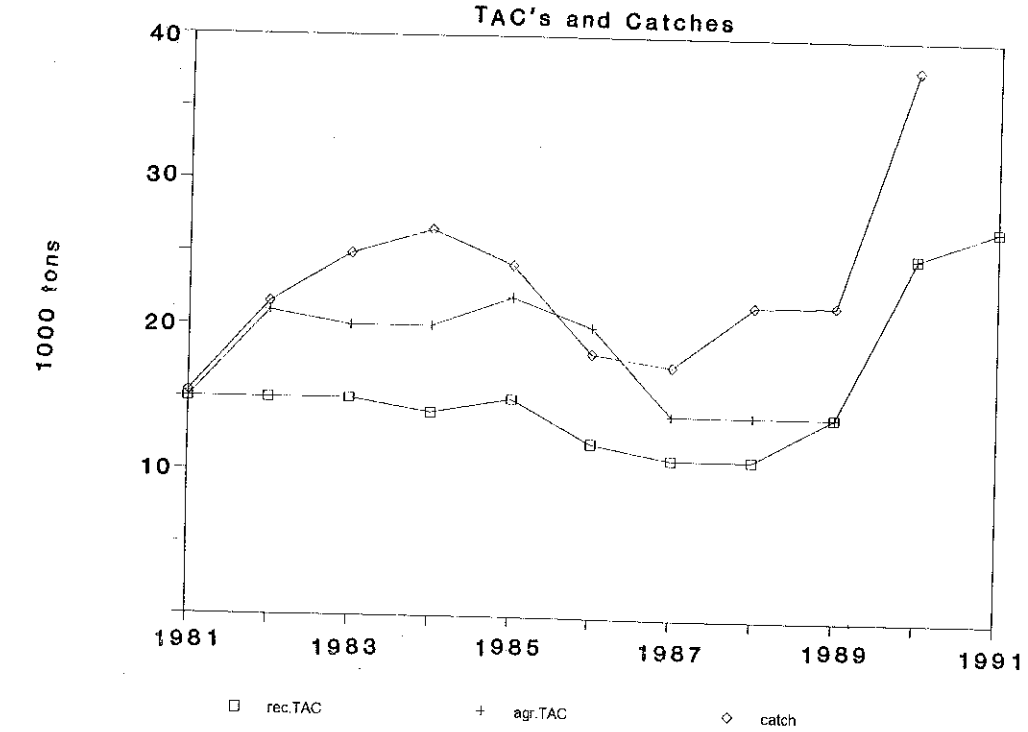

Figure 1

Plaice North Sea

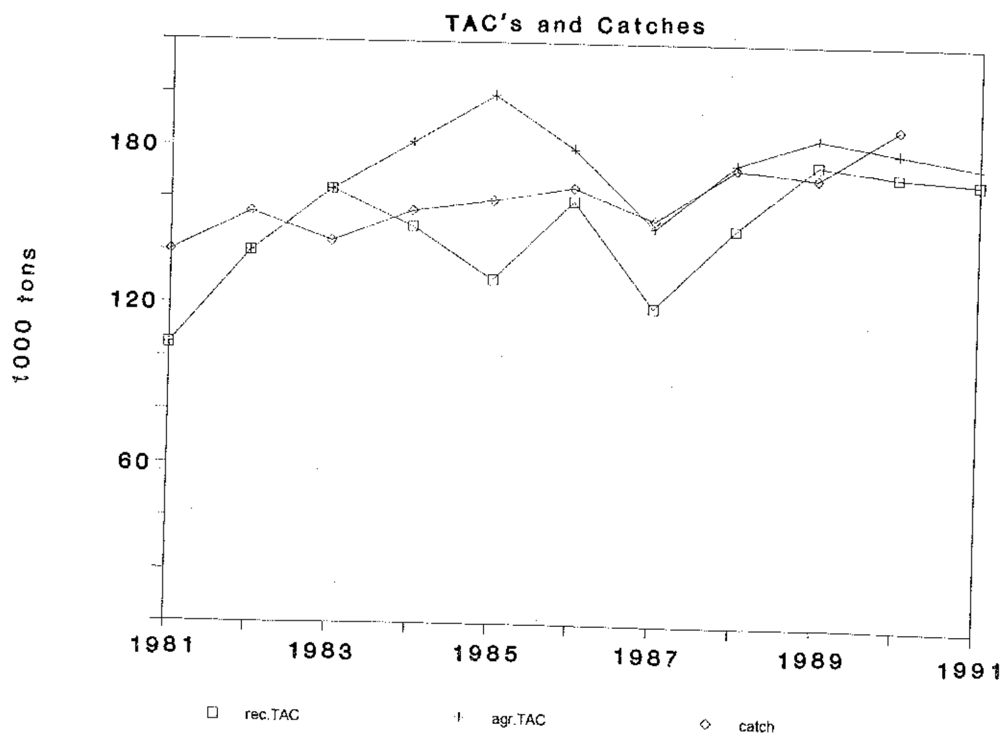

Figure 2

A similar reasoning may have caused of the advice on sole be disregarded, although here the biologists stated that the level of fishing actually endangered the sole stocks. But possibly the politicians have thought this to be mainly a matter of concern for the Dutch fishermen.

Turning to the roundfish species, — less important for the Dutch, but in general of far greater importance than flatfish — we see a rather different picture (figures 3, 4, 5).

Agreed TACs for cod seem fairly close to recommendations throughout the period. The largest differences occurred in the middle of the nineteen eighties, when sudden swings in recommended catch levels after a period of relative stability were not followed completely by the Council. Since then the TAC's show an alarmingly downward trend, and have more than halved from 220,000 t to 100,000 t over the decade. We will return to these features later on.

With haddock the decision-makers closely followed biological advice. Although they did not follow the swings completely, the difference was never greater than 20,000 t (being about 15% in 1987). Even more steeply than with cod, TACs have gone down since the middle of the nineteen eighties. From a level of around 200,000 t they have been reduced to 50,000 t, or just a quarter. This proportion is nearly disastrous, and not only for fishermen.

The whiting picture more or less resembles that of the flatfish. Before 1986 there were large differences between recommended and agreed TACs, the agreed being generally higher. From 1986 onwards, the TACs were fixed close to the recommended level, which remained relatively constant at around 130,000 t.

From the foregoing, it could be concluded that the fisheries administrators did not diverge as widely and as consistently from the biological advice on TACs as had been presumed. However, the recommended TACs in the ACFM data are the maximum options from biological advice. For roundfish generally, various options were given, with consequences for stock development and future catches. A reduction of fishing effort on roundfish was recommended throughout the period considered. Over the last years only the recommendations really have been well adhered to.

COD North Sea

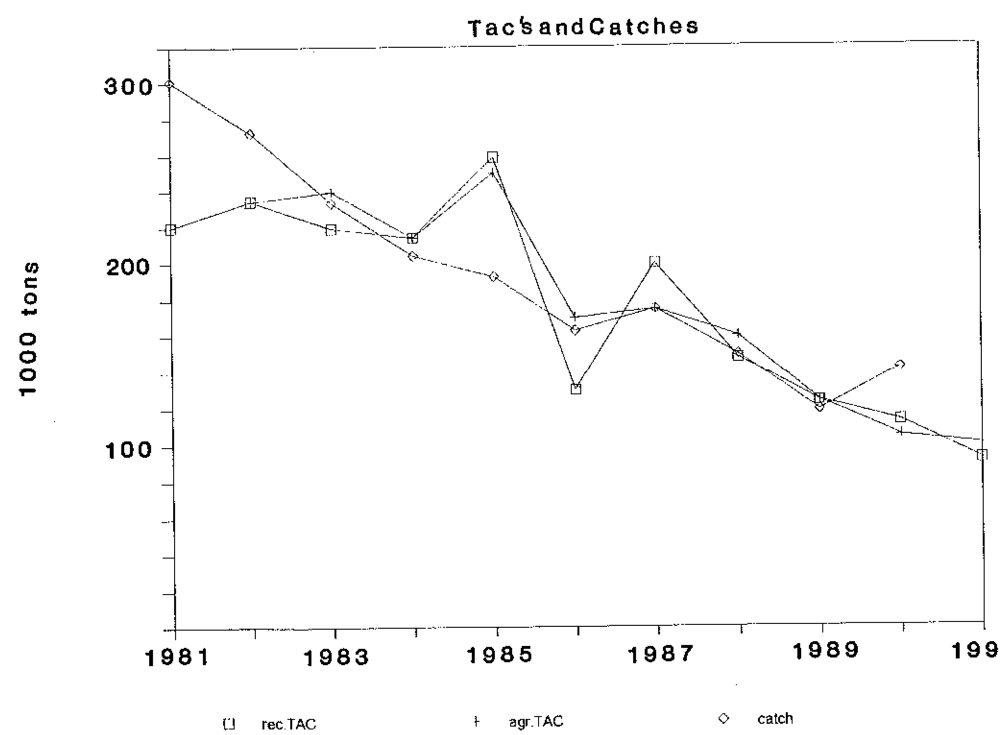

Figure 3

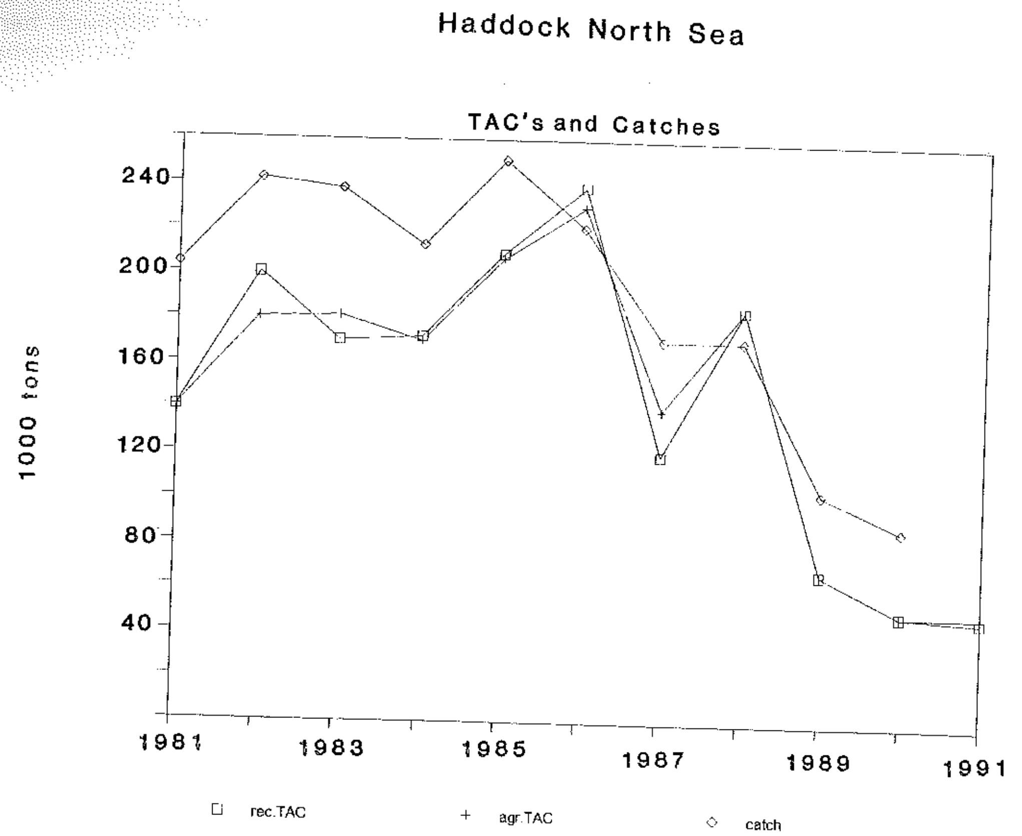

Figure 4

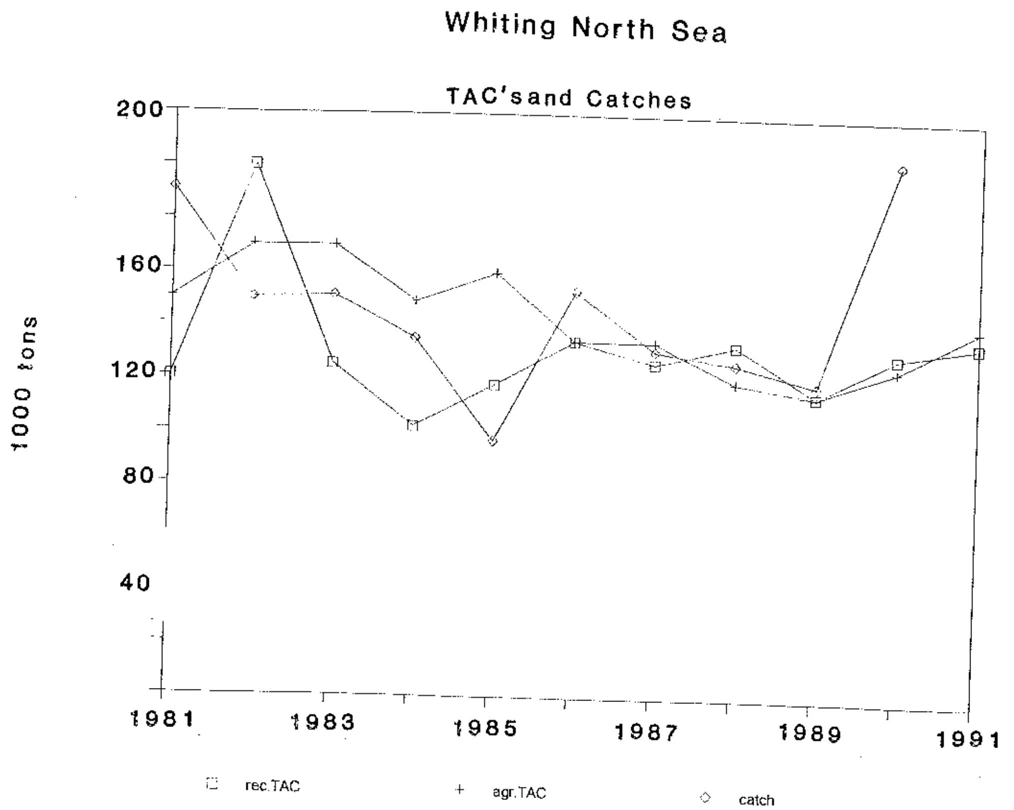

Figure 5

ACTUAL CATCHES

Some other interesting features beame apparent after looking at the graphs. Data on catches were included in the graphs, in order to check on the behaviour of the fishermen. These data represent the biologists estimates of what actually has been caught, rather than just reported landings. In some cases this gives rise to a lot of corrections.) Strikingly, only the catches of haddock and sole were almost consistently above TACs. Of the other species, catches were generally within the agreed TAC and on sometimes were even below the recommended TAC.

The case of cod fishing inspires some other thoughts on what is going on in North Sea fisheries management. After the establishment of the CFP, catches of cod have been close to, or even under (1985) TACs, with the probable exception of last year. This gives rise to the following remarks:

—In spite of not overfishing the TACs, these have gone down year after year since 1987, indicating a decrease of the cod stock; apparently even the biological advice did not help conserve the stocks.

—Catches show a smooth course and seem to follow a more stable pattern than TACs.

Similar observations can be made on the other species.

Haddock TACs were overfished most of the time and this may be the main reason for the decline of catches and stock sine 1985. During this decline, the biologists twice saw fit to recommend a TAC that was not caught in the end, raising doubts about the advice. Again the TACs show large variations, while actual catches run rather smoothly.

Since whiting seems to be the species that prospers best under the present management regime, the stock is about 50% above the 1983 level. Here the agreed TACs show the most stable pattern, although this is only an apparent stability as will be seen later on.

Catches of plaice show a smooth, slightly rising line, with TACs, recommended or agreed, varying around it. This stock is in good shape and offers no particular problems.

To a certain extent the same can be said of sole, although this is more the result of the strong year — class recently entering the fishery, than of effective fisheries management. Catches have been consistently higher than agreed TACs (except for 1986) and show a wave-like pattern. Here the recommended TAC seems to be the most stable.

FISHING EFFORT

The observation of a relatively stable course of the catches of most species during the period under review leads to a new thesis: stating that fishing activities eventually are more stable on their own than when is being followed following biological advice.

In order to study this thesis more closely, from the assessments of the actual average fishing mortalities given in the ACFM reports, those going with the recommended and agreed TACs have been derived. In a given year, with a certain stock composition, catches will be proportional to average fishing mortality percentages and vice versa (within certain limits). So average fishing mortality rates can be estimated for various catch levels when one combination of catch and mortality is known. The average fishing mortalities for actual catch, recommended TAC and agreed TAC have been transformed into Fishing Mortality Indices (FMI), taking FMI_{catch} in 1983 as 100(%). The resulting FMI_{rec} and FMI_{agr} are visualized in Figures 6 to 10, together with FMI_{catch}.

According to fish population dynamics theory, fishing mortality is proportional to fishing effort. Thus the FMIs found in a certain year represent the relative levels of fishing effort required to produce the TACs and the actual catch. Although there are some theoretical objections to it, for our practical purpose's we will not wander far from the truth by extending this over the years. So in the following the course of FMIs is considered to be representative for the course of fishing effort.

The relative stability already observed with the actual catches is even more strikingly apparent with the catch mortality indices. For all species under review, FMI_{catch} is more or less constant and follows a more gradual course than both FMI_{rec} and FMI_{agr}.

Again cod is the most clear example, with FMI_{catch} dropping slightly under, but staying close to 100(%). FMI_{rec} shows variations of up to 50% plus or minus around this level, while those of FMI_{agr} are somewhat smaller.

Cod North Sea

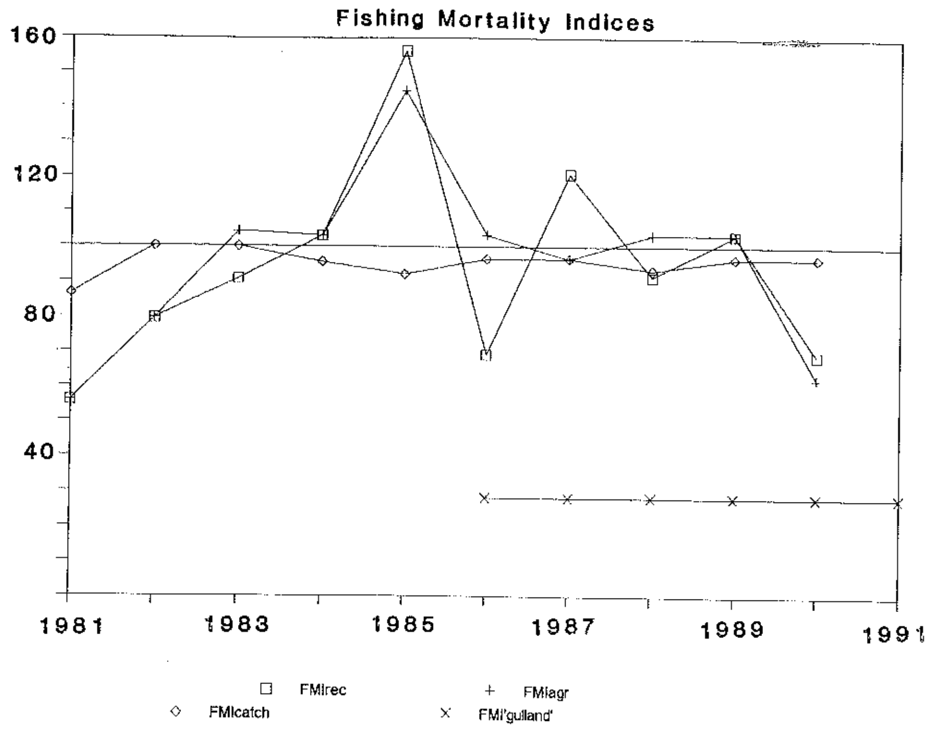

Figure 6

Haddock North Sea

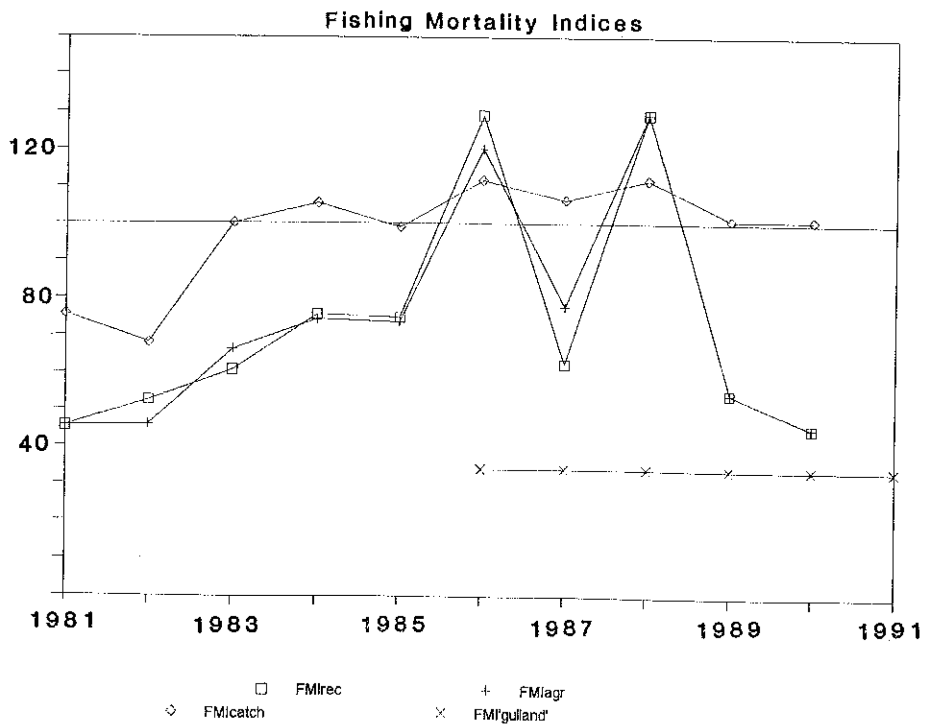

Figure 7

Whiting North Sea

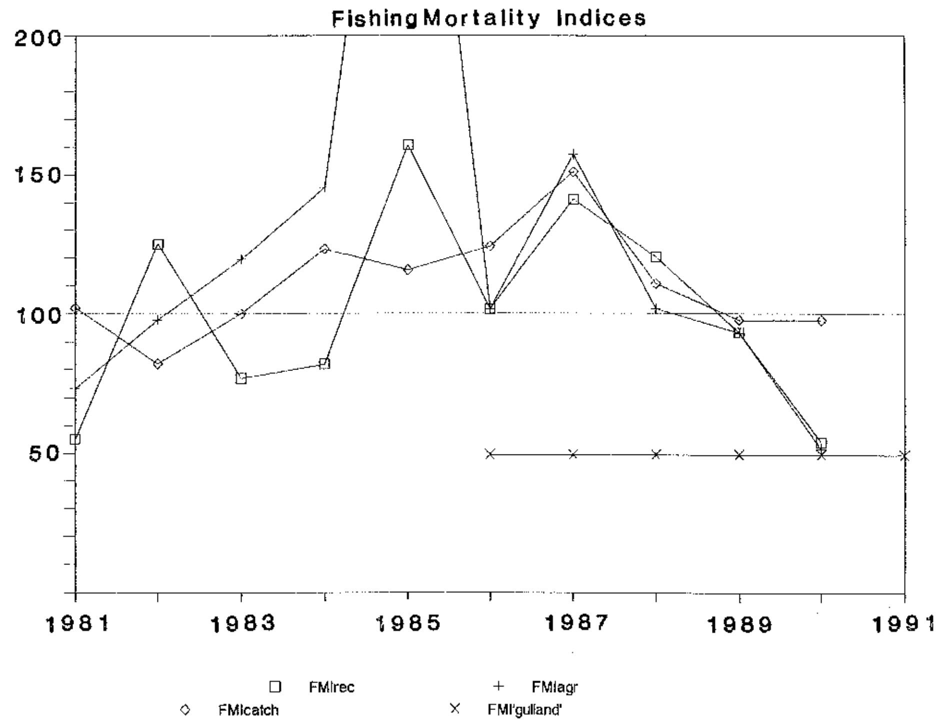

Figure 8

Plaice North Sea

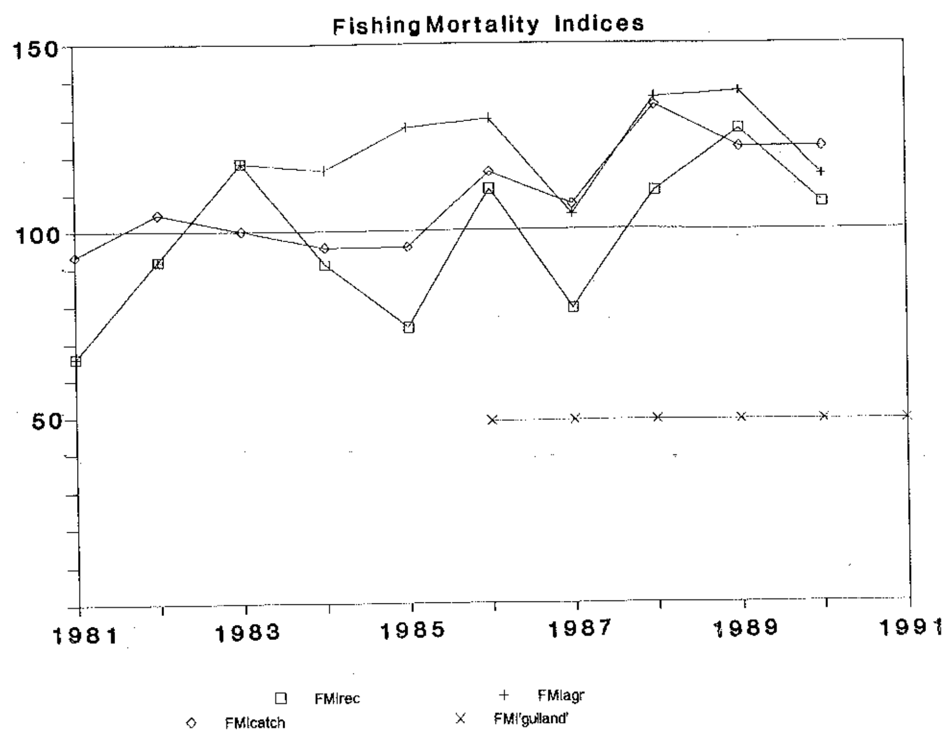

Figure 9

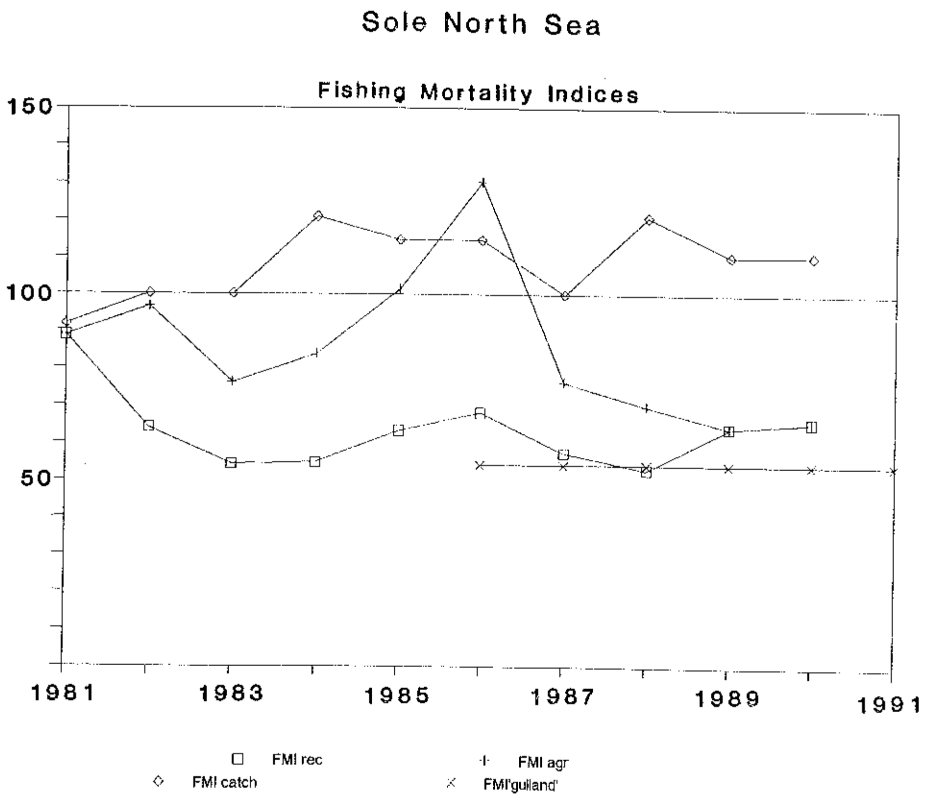

Figure 10

After the establishment of the CFP, the fishing effort (mortality) for haddock rose by some 10%, but dropped again to the 1983 level. The recommended and agreed allowable effort levels were generally well under 100(%), but for some reason were twice put higher than the actual fishing effort.

Effort (mortality) on whiting increased more or less gradually to 150% in 1987 and then went down to the initial level. The agreed allowable catch once corresponded to a mortality rate of over three times the actual 1983 level.

Plaice and sole seem to indicate a more definite rise in fishing effort by 20 and 10 percent respectively. Only with sole the biological advice seems to have been as stable as the fishery itself, be it consistently on a 40% lower level.

The stability of the mortality indices can be measured by expressing the standard deviation as a percentage of the mean value. The results are given in Table 1.

TABLE 1

Standard deviations of fishing mortality indices as a percentage of the mean value by species

Species	FMI_{rec}	FMI_{agr}	FMI_{catch}
cod	29	25	4
haddock	41	39	14
whiting	33	63	17
plaice	20	18	12
sole	16	22	9

Table 1 confirms the impressions given above. For all species the actual variations in fishing effort (mortality) were smaller than those that would have resulted if the fisheries had strictly complied with the recommended or the agreed TACs. For whiting and sole, the recommended level of fishing was less variable than the level with the agreed TACs.

One explanation for the variability of the biological advice on TACs lies in its uncertain basis. At the time the advice is required — the end of the year — firm data on catches and consequently on fishing effort are not yet available. So for a preliminary assessment of the stock at the start of the coming year, the ICES working groups estimate catches in the present year and assume that fishing effort (mortality) has been the same as in the previous year. This, as we have seen, is generally not very far from the tratz. For an estimate of recruitment the findings of young fish surveys are being used. But since the size of stocks and recruitment, can be firmly assessed by the Virtual Population Analysis only after a number of years have passed, there is apparently a wide margin of error. The wide sweeps in recommended TACs for some species further suggest that after overshooting fishing opportunities in one year, the biologists tend to undershoot them the next year (and vice-versa).

However, in their advice the TACs are only the result of an estimate of potential catches at desirable levels of fishing effort, meaning that this really is the guiding factor in the advice. This has been made most explicit in the advice for roundfish for 1991, recommending an effort reduction of 30%, without giving TACs.

The variability of the biological advice, combined with the apparent stability of the fisheries themselves, lead us to conclude that fisheries management should be aimed at the input — effort — rather than at the output — catches — of the industry.

Of course, this need not necessarily imply the major effort reductions recommended by the 'Gulland' Commission as indicated in the graphs. Only in the case of sole has the effort recommended by ACFM been consistently close to that level.

CONCLUSIONS

1. In fixing TACs for North Sea demersal species the decision-makers have kept closer to biological advice for roundfish than for flatfish.

2. The stocks about which the administrators tended to diverge from biological advice are in a better condition than those where they followed the advice more closely.

3. Fishing effort by species has been relatively stable since the establishment of the Common Fisheries Policy, showing a slight increase for plaice and sole and a return to the initial levels for haddock and whiting.

4. Biological advice is basically unstable because of the lack of firm data at the appropriate time.

5. Fisheries management should concern the input side of the industry, regulating effort, and not try to regulate the output, which is still inpredictable.

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Appendix

ACFM data on North Sea demersal species

SOLE

-year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Recommended TAC	15.0	15.0	15.0	14.0	15.0	12.0	11.0	11.0	14.0	25.0	27.0
Agreed TAC	15.0	21.0	20.0	20.0	22.0	20.0	14.0	14.0	14.0	25.0	27.0
Actual catch est.	15.4	21.6	24.9	26.6	24.2	18.2	17.4	21.6	21.7	38.0	
Sp.stock biomass	25.3	35.4	41.5	44.4	41.3	33.9	28.8	37.8	29.8	69.9	58.0
Recruitment (age1)	149	153	141	69	78	14	48	450	106	99	
Mean F(2-8,u)	0.44	0.48	0.48	0.58	0.55	0.55	0.48	0.58	0.53	0.53	

PLAICE

year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Recommended TAC	105	140	164	150	130	160	120	150	175	171	169
Agreed TAC	105	140	164	182	200	180	150	175	185	180	175
Actual catchest.	140	155	144	156	160	165	153	173	170	189	
Sp. stock biomass	296	285	310	307	336	330	364	348	382	377	345
Recruitment (age1)	412	994	572	595	505	1317	548	628	574	584	
Mean F(2-10,u)	0.42	0.47	0.45	0.43	0.43	0.52	0.48	0.60	0.55	0.55	

COD

year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Recomm. TAC (max)	220	235	220	215	259	130	200	148	124	113	92
Agreed TAC	220	235	240	215	250	170	175	160	124	105	100
Actual catch	301	273	234	205	193	163	175	150	119	142	
Sp.stock biomass	173	168	135	116	107	97	89	84	85	87	
Recruitment (age1)	272	559	269	534	108	581	257	201	324	161	
Mean F(2-8,u)	0.77	0.89	0.89	0.85	0.82	0.86	0.86	0.83	0.86	0.86	

HADDOCK

year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Recomm. TAC (max)	140	200	170	172	209	239	120	185	68	50	48
Agreed TAC	140	180	181	170	207	230	140	185	68	50	50
Landings acc. WG	147	185	172	138	165	169	112	109	78	63	
Actual catch	204')	242')	238	213	251	221	171	171	104	88	
Sp.stock biomass	228	285	241	190	231	213	150	149	122	86	81
Recruitment (age0)	30.0	18.9	63.5	16.1	22.7	45.3	5.7	10.5	12.8	53.9	
Mean F(2-6,u)	0.71	0.64	0.94	0.99	0.93	1.05	1.00	1.05	0.95	0.95	

WHITING

year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Recomm. TAC (max)	120	200	125	102	118	135	127	134	115	130	135
Agreed TAC	150	170	170	149	160	135	135	120	115	125	141
Landings acc. WG	146	105	103	96	69	76	78	100	84	150	
Actual catch	191')	150')	151	135	97	154	132	127	119	204	
Sp.stock biomass	451	349	303	247	242	266	278	283	365	474	444
Recruitment (age0)	23.7	20.7	32.4	23.9	47.6	39.2	50.1	72.0	48.2	49.8	
Mean F(2-6,u)	0.72	0.58	0.71	0.87	0.82	0.88	1.07	0.78	0.69	0.69	

') estimates by extrapolation of unreported catches

Source: ICES/ACFM Report Extracts 1987-1990

Attitudes Towards Fishing Capacity

E.A.F.E. discussion paper

by

NIELS VESTERGAARD and HANS FROST

Danish Institute of Fisheries Economics Research (DIFER), Esbjerg, Denmark

ABSTRACT

This paper argues that the overcapacity problem is sustainable as long as the market sends out wrong signals to the agents.

The regulation of catch and effort generates economic rent only in special cases because the market failure still exists.

The market failure gives the fishermen incentives to dissipate resource rent; the ability of doing that depends on the possibilities of transformation of species in harvesting and of the substitution of production factors.

If the regulation does not try to correct the market signals, the (new) role of the economist will be to point out the possibilities and the magnitudes of transformation and substitution.

1. Introduction

1.1. The EC Commission's proposal about reducing the EC fleet is prompted by the belief that the ability to catch fish exceeds substantially what is needed to take the total allowable catch (TAC). The fishery is overcapitalized or has overcapacity. Since there can be several economic reasons for keeping fishing capacity above what is minimally required to catch the fish available — e.g. weather, variability of fish stock abundance, alternative fisheries and competition — the concept of capacity discussed here is technical capacity, one that is based on estimates of hold size.

The fishing capacity must be related to some measure of the economic efficient use of both the fish resource and the invested capital. From an economic point of view, capacity is a function of economic and biological conditions and so a unique number for capacity hardly exists. Estimation of what a fleet will catch needs, *a priori,*

- a given set of economic and environmental conditions
- a concept of capacity related to economic efficiency
- a time horizon for the analysis.

1.2. The paper outlines the capacity problem in a traditional bioeconomic model like the Gordon-Schafer one and discusses the assumptions behind the model. Three different attitudes towards the capacity problem are then discussed.

2. Biological and economic capacity in the Gordon-Schafer model

2.1. The Gordon-Schafer model can be presented graphically by Figure 1. The total revenue curve TR shows the sustainable revenue of the stock as a function of fishing effort E. The total cost curve TC is assumed to be proportional to effort. For a further introduction, see Clark (1976).

2.2. Economic rent or resource rent is defined as the difference between total revenue (TR) and total cost (TC) and maximization of the economic rent occurs when MR = MC. (E = E(MSE) in Figure 1). Economic overcapacity from a society's point of view emerges, when the marginal cost of effort exceeds the marginal revenue of effort (when E > E(MSE) in Figure 1). Biological overcapacity emerges when E > E(MSY) (see Figure 1). With changed conditions (e.g. increasing costs), the capacity from a biological point of view will stay constant at E(MSY), while from an economic point of view the optimal capacity will decline.

Figure 1. Gordon-Schafer Model

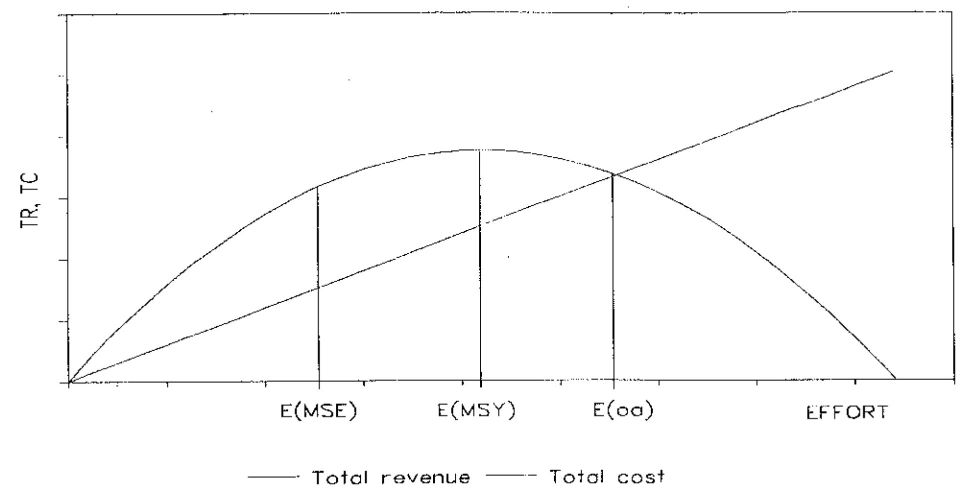
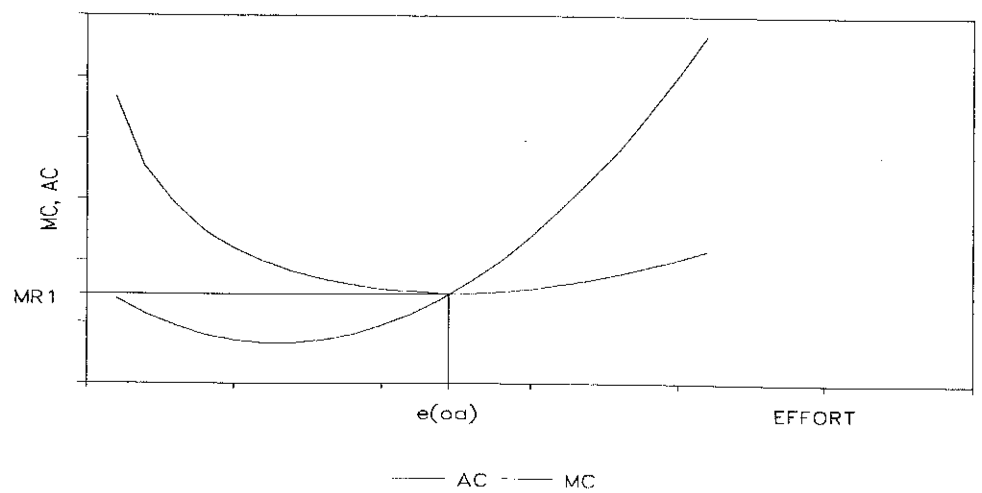


Figure 2. Individual Choice of Effort



2.3. Under a free access fishery, the effort of the society is E(oa). If we assume normal cost-curves (see Figure 2), the correspondent effort level in the free access fishery for each vessel is equal to the minimum point of ATC-curve: e(oa). The production is efficient from the individual's point of view. It is a consequence of the free access. If for example MR > min AC the overnormal profit will attract additional vessels, which reduces catch per unit effort and hence MR. This process continues until MR = min AC (For the individual vessel MR is a constant function of effort, because price (p) and stock (X) is considered as exogenous, MR = p q X, using the assumption of homogenous vessels).

2.4. Any attempt to regulate the catch (TAC) or the effort in order to achieve a societat goal of MSY or MSE will lead to e > e(oa), because MR > MR1 where MR = MC in the fishing period. The aim of TAC is to reduce the total catch to, for example, MSY or MSE. The present catch has in a period been greater than the maximum growth of the stock (in Figure 1 to the right of MSY on the TR-curve). In a free access fishery, the adjustment will take place via changes of stocks and effort; thus the biological and economic equilibrium is obtained (E(oa)). If catches are reduced by TACs this results in excess capacity, because the fishing period will be shortened. However, in the short run the overcapacity is rational from the individual point of view as long as MR ≥ AVC (Andersen 1979) and in the long run as long as MR ≥ min AC, which is the case if the stock increases as planned by the use of TACs.

2.5. The major conclusion is that a free access fishery results in the dissipation of resource rent and an overcapacity in the number of vessels from society's point of view. However that overcapacity is rational from the individual's point of view. We are dealing with a problem involving a market failure. The market sends out incorrect signals. For a fishery regulated by the use of TAC, the overcapacity will be expressed as too many vessels *and* inefficient factor proportions, thus increasing the effort for the individual vessel, (Munro and Scott (1985) named these two kind of rent dissipation: Common property problem Class 1 and 2).

2.6. The concept of capacity is here defined in relation to efficient factor proportion (min AC) and the maximization of the resource rent (minimize the number of vessels). But other definitions could also be used (f ex. normal capacity utilization) and the objectives for the fishery will also influence the optimal capacity. It could be said that the above-used concept of capacity is the approach of positive economics. The Gordon-Schafer model is an abstraction, because analysis of multispecies and multipurpose fisheries and of heterogeneous vessels and the implication for fishing capacity is not possible in the model. Therefore more pragmatic steps are discussed below.

3. What to learn from the concept of technical capacity

3.1. The first step towards determination of the capacity in a fishery could be to calculate the technical capacity. Smith and Hanna (1988) define the technical capacity (TCA) as follows:

TCA = TCA (number of vessels, hold size, average use in the period, technical efficiency).

The hold size determines the upper limit of catch per trip. The average number of trips in the period multiplied by the number of vessels, gives for the capacity. The parameter technical efficiency measures the fleet's efficiency. If the fleet's technical efficiency is improved, then a greater catch should be possible with the same number of vessels and the same hold size. Examples of elements that improve the technical efficiency are adoption of new technology, new fishing methods, and knowledge about good fishing grounds, while for example exit of good fishermen reduces the technical efficiency.

Dividing the actual catch (TAC) for the period with TCA provides a measure for technical capacity utilization. This measure depends also on weather, market conditions and of stock variability. Comparison of figures for capacity utilization for single years gives a picture of the changes in the excess capacity. If the capacity utilization is decreasing, the economic efficiency will probably be decreasing too. But we do not get any information about the courses of the changes in the capacity utilization; for instance when would vessels enter or leave the fishery? The concept has no prediction power.

3.2. Smith and Hanna (1988) estimate for the Oregon Bottom Trawl fleet 1976-1985 the increase in the fleet's capacity. The number of vessels can explain 42% of the increase, hold size 32% and technical efficiency 26%. The concept highlights the problems concerning the regulation of capacity, because even the technical definition of capacity is a multidimensional function. Limiting the number of vessels is not necessarily an effective method of reducing the capacity, because fishermen could increase the hold size. As mentioned before, the concept has no economic foundation. Further, when discussing multispecies and multipurpose fisheries, it is difficult to use this concept of capacity.

4. The optimal fishery capacity approach

4.1. In this approach, estimates of the optimal size and composition of a fleet is provided using mathematical programming. The objective is often to maximize the total profit. The concept for capacity has an economic foundation, because the costs are included. One advantage of this approach is that it is possible to work with several fleets which can have different fishing patterns. A shortcoming is the assumption of a fixed proportion in inputs and outputs.

4.2. The value of that kind of analysis is the insight it provides into characterizing the optimal solution, but the optimized solution is often very different from the present situation and therefore almost impossible to implement. This approach does not incorporate the motives of the fishermen with respect to supply of effort. The reaction of fishermen to changes in regulation is therefore not incorporated, so the approach does not provide any guidance on the elimination of the overcapacity. One could say that the approach estimates the magnitude of an existing problem.

5. Control of capacity and behaviour modelling

5.1. If the methods in sections 3 and 4 are compared with the conclusion in section 2, we see that the problem about control of the fishery capacity is not solved. The market does not regulate the capacity to achieve economic efficiency. Regulation is necessary. As was mentioned in sections 1 and 2 the capacity is a function of economic and biological conditions. Part of these conditions are uncontrollable and unpredictable, making estimations of the optimal effort/capacity meaningless; but, besides that, we know that the capacity always will tend to be too big from society's point of view. Estimations of *the* optimal capacity have to be treated with care and it must be recognized that only some information about the magnitude of the capacity problem is provided,(Opaluch and Bockstael (1984) argue that "in the face of uncertainty an appropriate goal for fisheries management is the achievement of an acceptable range of target levels of effort").

As a consequence, it seems natural to concentrate on the means of controlling and measuring capacity, instead of finding *one* figure for the overcapacity.

5.2. The traditional bioeconomic model assumes implicitly a two-step optimization process. First factors are optimally combined to form an index: effort. Then effort becomes an input in the fishery production function. Only if the production technology is separable is it possible to aggregate factors into an effort-index. This effect is discussed further in the appendix. and for the multispecies version of the bioeconomic model, it is assumed either that the production is joint-in-input, i.e. only one production process exist or that the production is non-joint-in-input, i.e. production processes exist for each species, (Many single species fisheries are multiple-product fisheries as a result of product differentiarion due to output characteristics such as size). In the appendix it is specified what conditions have to be fulfilled to achieve consistent regulation based on the traditional bioeconomic model. The point is that the properties of the production technology show how regulation should be performed. If, for example, the production technology is joint-in-input, it is inconsistent to regulate each species isolated, because there are important technical and economic interactions.

5.3. The problem we are dealing with is known from economic theory as regulating the production of individual multiproduct firms:

$$Y = F(X)$$

where

Y, X are vectors of outputs and inputs respectively.

Assume now that the production technology is separable, and that we wish to control the effort via the inputs. It is possible to aggregate the outputs and inputs to indices, but because input control is chosen, we have to look closer at the internal structure of effort:

$$E = E(X_1,\ldots,X_n)$$

where

X_i is the input factors.

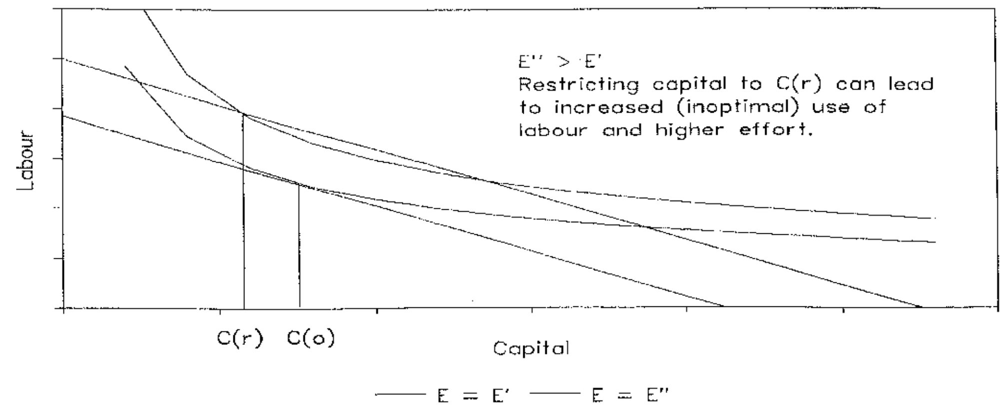
Input regulation can limit the use of certain inputs in production and/or can limit entry into the fishery. Limited entry may induce the fishermen to expand the fishing power of their vessels until all the rent is dissipated, i.e. total costs equal to total revenue. Since managers find that limited entry does not create economic rent, restrictions upon input usage per vessel are often imposed. For example, given restrictions on vessel tonnage, fishermen reoptimize over the reduced set of inputs and they may fish longer hours and use more labour and equipment; they substitute inputs for the restricted input. Regulations can introduce further restrictions and the fishermen will again respond by increasing the use of non-restricted input. The conclusion is that if inputs can be substituted, restriction on one input will lead to an expansion of other inputs and will increase the fishing costs and lead to resource rent dissipation. The success of input restrictions seems to depend

on whether fishermen can find substitutes for the restricted inputs or whether their creative skills are better than the manager's.

Figure 3 shows one possible response to capital restrictions. It is assumed that effort can be produced by the use of capital (vessels) and labour (gear). If effort is restricted by limiting the number of vessels, the costs of fishing will not increase. If fishermen are not allowed to invest they will spend more money on labour (gear), and the isocost-line will move outwards. Whether that will result in a higher or lower effort depends on the rate of substitution (elasticity) between labour and capital. Campbell and Lindner (1990) shows in a theoretical example that success with restricting a subset of inputs is more likely if:

- it is difficult to substitute non-restricted inputs for restricted input, and/or
- the restricted inputs proportion of the total factor costs is high and/or
- the economic pressure to exploit the stock is not too high.

Figure 3. Input of Labour and Capital



Dupont (1991) shows that restricted access and restriction on tonnage per vessels in the British Columbia salmon fishery lead fishermen within the seine fleet to substitute gear and labour which again to an increased use of fuel. Fishermen seem able to dissipate rent. For the gillnet-troll fleet, all the variable inputs (fuel, gear and labour) are complements to tonnage, showing the lack of ability to dissipate rent.

Munro and Scott (1985) conclude 'that there are too many inputs for all to be controlled effectively. Hence opportunities for substitution are never entirely absent'. Empirical work shows that knowledge about the production technology offers information about the internal structure of effort and further that Munro and Scott's statement in general is not correct. Regulation based on control of inputs could be (partly) successful and in accordance with the fishing firm's behaviour.

5.4. Restriction on output, which is not based on knowledge of the technology, can lead to unanticipated transformations and inefficiency. Regulation of one species can induce an increased catch of a non-regulated species, which are caught together with an another regulated species, cf. Figure 4 in the Appendix. That can lead to catches beyond the quota resulting in discards or illegal landings. The reaction from the authorities is often to increase the burden of regulation. See the appendix for a further discussion. Besides dissipating rent because of unanticipated transformation in output, the resource rent, could also dissipate because of an inefficient factor mix.

5.5. One approach that seems helpful in estimating the relevant parameters is the dual framework, (The dual framework imposes profit-maximizing behaviour on the fishermen and estimates the parameters of the production technology via the output supply and the input demand equations.

There are not imposed a priori restrictions on the production function (see Varian, 1978)), which provides knowledge of the individual firm's technology and costs. The approach models the fishermen's behaviour at the micro-level and could form the basis for effort regulation.

6. Conclusions

6.1. It is argued that the capacity problem arises because the market signals are wrong. The response from the authorities is often to introduce restrictions in order to control the capacity and fishing effort. These restrictions are in most cases quantity control, i.e. control of usage of input and output. Only very few countries use price (indirect) control. (An example of indirect control is the ITQ system. It is implemented in New Zealand, Iceland and partly in Greenland). The difference between the two types of control are — that price control tries to eliminate the market failure, while input and output control interfere with the production decisions by the individual firm.

If the authorities use input and output control that are inconsistent with the production technology (and behaviour) the result can be unexpected expansions in the usage of uncontrolled inputs and outputs. If the technology is fixed proportionally, then restricting one input cannot lead to expansion in the uncontrolled inputs. Therefore the rent from the fish resources can be preserved. But this is a special case and in general the capacity problem seems to be sustainable when using quantity control.

One technique to get some information about technology is available from economic theory. And it could be one role for the fishery economist to point out the possible transformation in harvesting and substitution of factor inputs and to try to estimate the elasticities.

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Appendix.

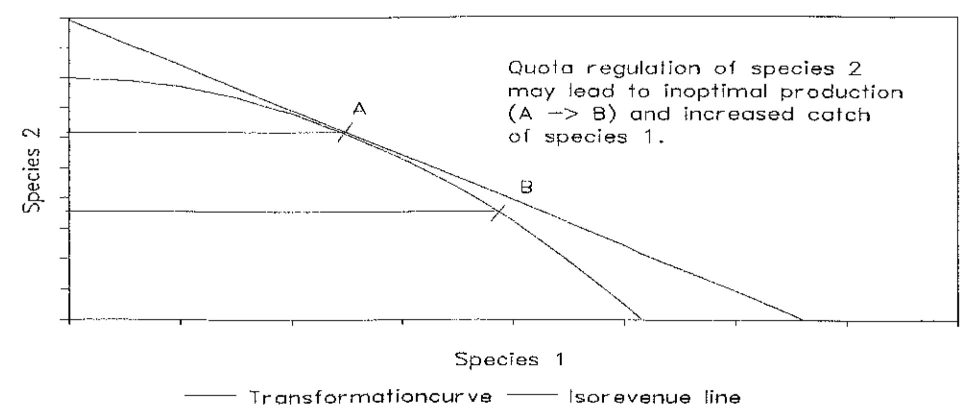
The implicit assumptions behind the traditional bio-economic model. (based on Squires 1987a and 1987b).

A.1. The regulation has so far conceptually been based on the traditional bioeconomic model, consisting of a single aggregate input, fishing effort and either an aggregate output, total catch or a separate production process and model for each species. This approach assumes a two-stage decision-making process. In the first stage, factors of production are (implicitly) combined to form a composite input: effort. In the second stage, effort becomes an input in the fishery production function, i.e. harvesting function. Furthermore the aggregate production function relates total catch to total effort and resource abundance in a restrictive functional form. Population dynamics and production gives steady-state optimal levels of catch, effort and abundance.

A.2. Typically, economists view fishing effort as an aggregate variable; an example is the Gordon-Schafer model. The aggregation is a critical assumption; it means that the production technology is separable. The decision on factor combinations is independent of the decision on target of species. If this assumption is not fulfilled, then any attempt to construct effort from the set of inputs will lead to an index for effort which varies with variations in volume and composition of the output (effort isoquants twist around and might even intersect) and it is not possible to obtain a meaningful scalar measure for effort. But if the assumption is fulfilled, then consistent regulation of effort is possible based on the relationship between factors of production.

A.3. The other assumption about either joint-in-input or non-joint production also can lead to disappointing results. For example, should the true multispecies harvesting technology be joint in inputs, then only one single production process exists for all the species. A bioeconomic single species model specifies a separate production function for each species and optimizes the level of effort and catch for only one of the many possible species in the fishery. The optimized results will neglect the other species and any possible species transformation in harvesting (see Figure 4).

Figure 4. Joint Production of two Species



Output regulation (ex. TAC) of each single species may therefore lead to catch discards, reduced income and inefficient product and factor proportions. In most cases the production is joint-in-input, which means that a separate harvesting process for each species does not exist.

Overcapacity in the European Fishing Fleets

Review of the Relevant Aspects and Proposition for an Economic Approach

by

PAVEL SALZ

Agricultural Economics Research Institute (LEI), The Hague, Netherlands

ABSTRACT

While the system of TACs and quotas probably will be maintained in the years to come increasing attention is being given to measures regarding fishing effort. The extent of these measures will depend on the estimated size of overcapacity. At the same time, it is being recognized that biology alone cannot provide satisfactory answers to the multidisciplinary problems of fisheries management, where technical, institutional, legal and economic factors play an equally important role.

The paper points out that in the past the potential contribution of economics has been under-estimated. It elaborates on the problem of overcapacity of fishing fleets from the point of view of the sector's commercial operation of. It indicates specifically in which fields economics may provide an improved understanding of the logic of the European fisheries and the relevance of this knowledge to the formulation of future fisheries management policies.

CONCLUSION

Contrary to the traditionally European-wide biological approach, the current economic analyses have been mostly limited by national boundaries and interests. Further integration of the European Community requires also an European-wide approach to applied research in economics, as well as other fields related to fisheries management. A specific research programme on the economic overcapacity of fishing fleets is proposed.

1. Introduction

The MAGPs are receiving an increasing amount of attention. This can be concluded from the suspension of the EC/FEOGA support for new construction in the first half of 1990 justified on the basis that various, though not all, countries have not achieved their MAGP targets. Furthermore Mr Marin has expressed the opinion, in his latest report to the Commission, that the EC fleets will have to be reduced by some 40%.

The objective of this paper is to elaborate upon economic aspects of overcapacity, which seem relevant fishery to management.

However, before getting lost in the intricacies of the subject, it seems equally relevant to look at overcapacity from the point of view of fishery biology, because this science has set the current definitions.

2. Biological approach

The biological definition of fishing capacity is expressed in terms of fishing mortality and not, as other sciences may be inclined to be, in terms of grt, hp or the number of vessels. Mortality is interpreted in relative terms, as a proportion of certain year classes within the standing stock.

From a biological point of view, this is a very sensible approach. It makes it possible to assume that the productivity of a certain gear remains constant (again in terms of relative fishing mortality) since it is determined by the state of the stock, i.e. the catchability. Furthermore, it is not necessary to look for a technical measure that would present important methodological and empirical problems. Definition of gross tonnage or horsepower is not unambiguous. Measurement and aggregation of the fishing capacity of different gears seems also rather imprecise: compare trawls, lines and gill nets. But fish do not care by which gear they are caught!

This approach allows for a straightforward definition of overcapacity. The total current mortality is composed of natural and fishing mortality. When the objective is to achieve a certain total mortality that is lower than the current one, the overcapacity is then equal to the difference between the current and the desired level of total mortality (possibly adjusted by a slight change in the natural one).

This has a very important and confusing implication. When the stock is small a large reduction of mortality is required (high percentage), but in fact this may not represent such a great amount of fish.

Even from a biological point of view, it must be recognized that this static approach is not entirely satisfactory for a long-term policy. In a situation of biological overexploitation, the biological conclusion is that it is desirable to lower the fishing mortality of the specific species in the short run to allow the stocks to recover, while later a certain increase of the fishing mortality may be allowed again, producing, it is hoped, some kind of equilibrium. There are at least three problems with this approach:

1. It is not the fishing mortality but the total one which matters. Therefore one species can be equally protected by increasing fishing mortality of its predators — multi-species relations.

   In this respect it is important to note that 'management biology' is especially worried about the fishing mortality of certain age-groups. These must be allowed to reproduce to maintain the stock, while their fishing mortality may be 5-10 times higher than the natural one. On the other hand, the natural mortality is very high for the young fish.

2. There may be a considerable choice of time paths. Less radical adjustments of the current level fishing mortality will make the time path to the desired equilibrium at a higher level of stock longer, but at the same time the social and economic pressures will be less grave since there will be more time for adjustment. Some biologists have indicated that this aspect has not been given much attention.

3. The assumption of constant productivity presumes constant fishing pattern, i.e. there is no flexibility of using one vessel in different fisheries. In many countries this would not be supported by empirical evidence.

Furthermore, it must be recognized that the natural mortality and recruitment depend to a certain extent on external environmental factors. Their relative importance still remains to be quantified.

The above considerations put the concept of overcapacity in a dynamic and more complex perspective. Still, it should not be concluded that overcapacity is not a problem. It only implies that its current definition is not satisfactory because it does not take into consideration some important factors and it is difficult to translate into the real world of gears and boat sizes.

As in all other fields of government policy, there is a need to formulate a long-term structural policy (in terms of desired size and composition of the fleet) as well as short term one (in terms of catch and effort adjustments to the regular changes in natural conditions).

The introduction of dynamics into the formulation of fishery management policies, however, will present some serious dilemmas for the policy-makers. The biologists have pointed out that in a multi-species approach there is not any single MSY which can be technically determined. Instead a political choice has to be made between various mixes of species. Explicit choices also have to be made between different fleet compositions and time paths of adjustment and development. Furthermore, short-term fluctuations of stocks have to be distinguished from the long-term trends, and there is a need for a very flexible policy response. It is questionable whether politicians are willing to deal with such subtleties.

3. Multidisciplinarity of practical management

Even if the fishery policy is formulated on the basis of dynamic biological considerations, biology offers a rather narrow base from the point of view of the practical implementation. Policy deals

with fishermen and biology with fish. The formulation of fisheries policies in the past seriously underestimated the relevance of the implementation phase. This has been often considered as a 'technical detail' to be taken care of at a 'lower level'.

Even the rather static concept of biological overcapacity, defined as excessive relative fishing mortality, has to be interpreted in terms of technology, economics, legislation and institutions. Therefore these aspects have to be taken into account concurrently with biology. The links between the various fields have to be analysed during the first phase of policy preparation instead of only during the very last one of implementation.

Technology
In practice we are dealing with a multi-species/multi-fleet situation. One gear catches various species and one vessel can switch to various gears and various fisheries, i.e. there is a considerable techno-biological flexibility.

Economics
The financial results of a vessel will determine how long it can survive in specific mix of fisheries. However, social considerations such as status or family business may considerably extend the life of a fishing enterprise beyond what could be expected on purely rational economic grounds.

Furthermore, various national and local governments have shown considerable alertness to the financial problems of the fishing industry (although it is rarely enough from the industries' point of view), making support funds available for social and political reasons. Even the current EC policy is counter-productive to structural management measures (i.e. reduction of fleet) since more money is available for new investments than for decommissioning.

Institutions
An effective follow-up of the TAC system requires that producers be carefully controlled. Although fishing may be a special case compared to other industries because of its specific characteristics, — wild exploitation of renewable natural resources, — it is questionable if such controls are at all feasible in an open market economy. In fact the TAC-system has rather centralistic consequences. It also remains to be seen whether a democratic society has either

- the institutional means (in theory and in practice), or
- the political will to make the necessary funds available for effective implementation. Since fisheries comprise a very small sector, of relatively little economic importance (except to fishermen) it is doubtful if it will ever receive the necessary — though disproportionate — institutional attention.

Legislation
Even if it does receive this attention, it is only a necessary but not a sufficient condition for drafting the required legislation. The nine member states that are directly involved in the Common Fisheries Policy have varying legal systems which will have consequences for the speed and severity of any judicial prosecution. The basic principles of democratic legal actions (proof of guilt, the independence of judges and the possibilities of appeal) make an effective fishery management policy difficult since only a certain percentage of infractions will be punished in the end. Two matters require further attention in this respect

- Are there inequalities between the different member states in the severity of prosecution.
- Can the Commission impose specific legal rules,such as administrative fines for specific infractions?

Currently it is doubtful if the CFP is being equally applied to all.

The above considerations make it clear that a mono-disciplinary analysis of fisheries management problems in general and those of overcapacity in particular cannot produce satisfactory results because fishing requires detailed and effective regulation.

4. Potential contribution of economics

The contribution of economics to a better understanding of fisheries problems has been reduced in the past (Lowestoft working group) to the calculation of future prices. The policy approach was simplified to the pursuit of maximum value of landings. This not only does not do justice to the potential contribution of economics within a multidisciplinary analysis of the fisheries problems, it is also strongly reminiscent of the approach to economics in Eastern Europe before 1989; value of landings without a consideration of the costs of production is meaningless. At the same time long-term prediction of prices is a rather stratospheric exercise with a commodity characterized by a truly global market and fair substitution possibilities. It cannot be expected that a changing abundancy of a certain species like cod will produce consistent price changes because the cod price will be effected by wide-ranging developments from Alaska pollack to South American hake or from African hake to Australian hoki. In fact historical evidence shows that the real fish prices remain rather constant in the long run (similar to various other primary commodities). Limiting the contribution of economics to one time determination of the long term real prices, seems rather meagre for a generally recognized social science.

Analysing the problem of overcapacity from an economic point of view requires that we:

- formulate a definition of fishing capacity in physical terms as a relation between units of gear and volumes of fish, — and
- make the essential distinction between the technical and economic overcapacity.

There are two reasons why the distinction between technical and various economic overcapacities seems relevant:

1. It provides understanding of the likely effectiveness of any policy which necessarily has to work through market mechanisms.
2. It raises the politically sensitive aspect of income distribution (size of employment, labour versus capital, regional, groups of fishermen and so on). This goes parallel with the choice between the various MSYs in a biological multi-species approach.

4.1 Definition of fishing capacity

Until now no unambiguous physical definition of fishing capacity has been developed on an European-wide level because of the lack of well-coordinated research on this matter and the heterogeneity of the fishing activities. It is demonstrated below (see 4.1) that, with the current level of knowledge a clear definition may prove rather difficult.

The meaning of the grts and kws used in the MAGPs should be questioned because measurement of these units is not standardized. There are examples of vessels and engines where two different approaches to measurement produce values which differ by factor 1.5-2. However, it is not only a matter of specifying a common definition but equally of its practical application to the already sailing fleets. In practice, this will be rather costly because thousands of vessels would have to be remeasured. On the other hand, applying the new definition to the newly constructed vessels would provide comparable data on fishing capacity only in twenty years time.

Unfortunately, an assessment of the overcapacity cannot wait for a practical solution of the above definition problem of fishing capacity.

4.2 Technical overcapacity

The technical capacity could be defined as the quantity of fish (mix of species) which could be caught annually by a specific vessel or a fleet. It will depend on:

- productivity per unit of fishing time (cpue or kg/hour)
- number of fishing time units (hours fishing/year)

The productivity of a vessel will further depend on:

- quality of the skipper and crew
- type, size and power of the vessel, its equipment and gear
- relative density of stock (catchability).

The number of units of fishing time depends on relations between

- time in port
- time at sea
- time fishing.

Obviously fishing time can be increased by reducing the other two, i.e. shorter stays in port and fishing closer to the home port, instead of steaming to distant grounds.

The technical capacity can be used in varying degrees. A considerable flexibility in the capacity utilisation is quite characteristic for fishing vessels. In practice there is something like a 'normal' level of capacity utilisation. Very high (maximum) capacity utilisation of over 300 days a year can be achieved, while in some fisheries vessels are economically operated on 1-2 months fishing per year. For small coastal fleets, sea time and fishing time may lie close to each other (short trips, weather dependence, close grounds). However, the medium and large vessels especially will be able to maintain their fishing effort in case of policy limitations by changing the pattern of the three above-mentioned factors of port-sea-fishing time.

It is not clear whether the current level of fishing time is higher or lower than the normal one. On one hand, there are some restrictions (quota) on the other hand, the fish are more difficult to catch and, when higher costs have to be covered, this may well lead to more fishing time in order to achieve the same catch or net revenue.

The relation between the biological overcapacity and the technical one is not as straightforward as may seem at first. A reduction in the nominal number of grts or hps (even if they are well — defined) does not necessarily produce a proportionate reduction in fishing effort and even less that of fishing mortality. These relations need an explicit analysis. It can be expected a priori that the less productive vessels will be withdrawn first while the capacity utilisation of the remaining ones may increase.

4.3 Economic overcapacity

The introduction of economics into the analysis of overcapacity implies in the first place that costs and revenues have to be included. At a later stage, aspects like income distribution, regional analysis and possibly secondary effects may be taken into account.

The economic overcapacity could be defined as that part of technical capacity which cannot be exploited economically. This leads to a concept of overcapacity which is more related to economic activities and less to fish stocks. Small catches at high prices can still sustain a considerable fleet on an economically sound basis.

The economic overcapacity has to be interpreted within different time-schedules (short, medium and long term) because of the dynamics of the survival of the firm under difficult economic conditions.

The free market is undoubtedly of considerable influence on the effectiveness of fishery management policy. The relevance of economics lies in its analysis of the behaviour of the fishing firm or of the sector under the restrictions or incentives of the fishery management policy and the market.

It was assumed that administrative or technical regulations would be able to steer the sector in certain direction. However, empirical evidence shows that it is legally impossible to force specific people out of business just because the fleet is considered to be too large if it cannot be legally proven that they do not comply with the management rules. Practice also shows that judicial prosecution has not been a serious deterrent to prevent infractions. It is only possible to make the economic existence of the marginal firms difficult and to help their decision to stop fishing with some decommissioning scheme. Therefore an analysis of costs and benefits is relevant from the point of view of degree and time schedule in which the technical overcapacity can be eliminated with the usual policy instruments which are only indirectly effective through market forces.

How long a fishing firm will survive under difficult economic conditions, and thus maintain the fleets overcapacity, will depend on its financial reserves built during the previous years, its relationship with its bank, its cash-flow and the acceptance of its owners and crews of lower incomes. Non-economic considerations such as maintaining a family business, status in the community ***and alternative employment opportunities,*** may play an equally important role as the economic ones.

A firm will survive in the long run if the proceeds will cover all costs. It is the fiscal and social security system which is relevant in this context and not a specific economic approach.

In the medium term a firm will survive when it can meet its obligations to the banks, but it does not necessarily have to be able to earn back the depreciations on its own capital. The extent to which the firm will consume its own capital will depend strongly on factors like social status and future expectations. In case of fishing it may be expected that many people will hang onto their boats as long as possible since they are their livelihood.

In the short run, a firm can survive purely on a cash-flow basis because the banks will wait for a few years for the loan reimbursements. Some countries give their fishing industries quick support to get it through the difficult years.

The various time schedules require different levels of gross revenues. In the short run a firm will survive with relatively lower earnings so that lower catches and a lower use of technical capacity are acceptable.

From the above it follows that there are various levels of economic overcapacity. In the long run there may be a considerable economic overcapacity, but that is not necessarily the case in the short run. Consequently any measures taken to limit the size of the fleet will become effective only gradually. A high percentage of the costs of fishing operations is variable, being related to sea time (fuel) and gross revenues (crew share). Possibly contrary to other industries, survival on a cash-flow basis is an accepted part of fishing operations because of the natural fluctuations of landings and thus of economic results.

Five levels of the utilisation of technical capacity were distinguished.

1 Maximum — In an extreme case a vessel may work over 300 days a year, 24 hours a day

2 Normal — There is a certain normal level of capacity utilisation, which can be determined from historical data. This will be often some 150 days for smaller vessels and 220-280 days for the larger ones.

3-5 'Financial' — Three levels of capacity utilisation may be distinguished according to the short-, medium- and long-term financial requirements.

It cannot be determined a priori where the three financial levels will be in relation to the maximum and normal level since that will depend on the achieved physical productivity (per sea-day) and the prices. In reality the situation becomes further complicated because:

- Various fleets are exploiting the same stocks with various gears and thus also with various 'costs and earnings functions'. Therefore it cannot be expected that a policy to protect a certain stock will be equally effective on all fleets. This may have far-reaching consequences as far as the intended and the realized reduction of fishing effort are concerned.
- The fleets can switch from one target species to another and thus reduce overcapacity in one fishery and increase it in another. Such flexibility forces the policy-makers to introduce more detailed and complex regulations, which in their turn are more difficult to implement.

Various fisheries (combinations of vessel/gear/target species) have differing income-generating and distribution characteristics. Empirical economic analysis is required of the consequences of heterogeneity and flexibility in multi-fleet/multi-species situations on the effectiveness of policies aimed at a structural reduction of the fishing effort. This heterogeneity is typical for the waters of the European Community.

5. Who wants an economic analysis?

Some of the matters raised are rather controversial and it is not at all self-evident that the policy makers are interested in an objective analysis since it may uproot some preconceived ideas which are suitable for general political discussion. Two examples may illustrate this, though in practice there are many more.

First, there is the aspect of income distribution. In general political discussion this aspect is treated in a qualitative manner. Economic analysis may well produce undesired quantification. For example: From an EC point of view it may be more desirable to give the available fish resources to regions like Galicia or Brittany instead of to Holland, Denmark or oil-rich Scotland. For national representatives who defend the interests of their countries in Brussels, such shifts would be unacceptable.

Second, since various national fleets are exploiting the same stocks it will be absolutely essential to elaborate a clear definition of fishing effort and determine its current level. This would imply that:

- all fish stocks would have to be considered as protected TAC stocks
- coastal fleets (below 10m) would have to be accounted for because they are fishing in sensitive areas (nurseries)
- the truly active fleets in each country would have to be determined
- one definition of grt, for example, would have to be applied to all because, otherwise fleets may be also reduced by simple remeasuring.

As things now stand the MAGPs of various countries have been determined on rather questionable fleet data — usually the registered fleet, which is often larger than the active one, with no consistent measurement of grts or kws. Considerable margins have been created which will allow if necessary for 'paper reductions' of the fleets in the future or even for an increase of the effective fleets.

Still, economic analysis may provide some interesting insights into the less sensitive issues as, for example, which is the prohibitive level of fines, relation of policy costs and value added of the industry, consequences of policy-induced inefficiencies, role of the secondary linkages of the sector or the likely effectiveness of a policy working through market incentives.

The potential future role of fishery economics within the multidisciplinary approach to fishery management will be determined partly by its capacity to deal with sensitive political issues in an objective and 'scientific' manner.

For those involved in empirical policy related research in fishery economics, there are many more questions than answers.

6. Proposition for economic research

It is evident that not only the concept of economic overcapacity has to be further refined and subsequently applied to empirical data. It must be recognized that coordination and execution of European-wide research in fisheries economics lags various decades behind that of biology. The problem of the overcapacity of fishing fleets in relation to the available stocks calls for extra effort in this field.

It is therefore proposed to launch a European-wide research programme which would aim at:

1. Formulation of a consistent methodology on the economics of fishing capacity and overcapacity.
2. Review of the relative importance of the various empirical data required for the application of the theory (capacity definitions, assessment of statistical data, and so on).
3. Empirical assessment of the economic overcapacities in the major fisheries and their implications for the effectiveness of fisheries management policies.

The Measurement of Overcapacity as a Management Tool: An Economist's View

by

MASSIMO SPAGNOLO

Instituto Ricerche Economiche Pesca e Acquacoltura (IREPA), Salerno, Italy

ABSTRACT

Fisheries management measures are heavily dependent on biological concepts. Overcapacity or, it might be better to say, overfishing, is still defined as that generating the difference between the current and desired levels of total fishing mortality where the various Maximum Sustainable Yields (MSY's) are utilized as policy targets.

Economists are usually dependent on the same concepts and their analyses often conclude that the desired level of fishing effort is close to some specific Maximum Economic Yield (MEY), which is close to some MSY. If this is true, fisheries economists will always depend on a biological curve that is outside their control. The same is true when technical bio-economic models are considered. While the problem could be overcome by closer co-operation between biologists and economists, it is clear that economists should develop an autonomous way of thinking in order to satisfy policy-makers' requirements. This means developing widely acceptable economic definitions of fishing effort, fishing capacity and such concepts and their use as routine management tools for policy purposes.

Lack of tradition, of available and comparable data, of common research projects and, not least, the merely residual funding usually available for research in fisheries economics in many countries, tend to limit this approach.

On the other hand, the broader concept of fishery planning is becoming a substitute for fishery management, and this allows economists to use more familiar methodologies. In this case, conservationists' measures are only one of the many options available to satisfy policy goals.

INTRODUCTION

Since 1954 the sustainable yield curve has been the basic tool on which economists have built most of their theories about fisheries management. Concepts like Maximum Economic Yield are well established in the literature. For a long time the distance between MEY and MSY has been an apparent source of debates and conflicts that became less relevant as economists introduced welfare considerations that brought MEY nearer to MSY for fishery policy purposes.

Unfortunately, this conclusion did not lead to a greater co-operation between biologists and economists; indeed, it pushed them further apart because if the target is MSY, then biological tools are appropriate for sound fisheries management.

However, in more recent years, parallel to the many failures in managing the resources by conservationist measures and provision of good biological forecasts, politicians and public administrators have been willing to recognize an increasing role for the proposals and suggestions of economists. At the same time, it seems to be now well accepted that fishery management has wider and more complex implications which underline the need to adopt sectoral planning, where biology is only one of the variables involved.

There are many reason why it took so long to reach this point, but it has to be recognized that economists have had little opportunity to present different methodologies, either because of the well-established position of the biologists, or because the economists' approach has its roots in biological theory. It is self-evident how difficult it might be to depart from the dominant view when the same conceptual framework is used.

If this is true, then it is clear that there is a need to develop an autonomous economic approach to fishery management. This can be obtained only departing from the traditional bioeconomic approach. In this case, if I am allowed to quote Keynes' preface to the General Theory of Employment, Interest and Money, "the difficulty lies, not in new ideas, but in escaping from the old ones". Concepts like MEY have to be abandoned and the definitions of management concepts like 'overcapacity' or 'fishing effort' have to be interpreted in economic terms.

ECONOMIC YIELDS AS A MEASURE OF OVERCAPACITY: A PROPOSAL

Many European fisheries, if not all, are overexploited. Overexploitation is achieved through different fishing systems, each of which has a different impact on the resources and a different flexibility which allows for divergent reactions to management measures. Therefore, it cannot be taken for granted that the reduction of fishing units or other technical parameters will necessarily reduce fishing effort. It is well known that it could have the opposite effect.

However, overexploitation implies that the fishing fleet has redundant capacity; hence the concept of overcapacity postulates a situation of disequilibrium. This is usually defined as the difference between the actual and the desired levels of fishing mortality, but in the economic terms it could well be defined as those combinations of yield/effort (Y/E) which are lower than a given or desired average registered for each segment of the fleet. The first difference emerging from the two definitions concerns *when* there is overcapacity. The second difference lies in *which* are the redundant units of effort. A third difference is related to the efficiency of the measures that are necessary for there to be a return to an equilibrium.

The importance of these differences has to be explained since they represent the core of an alternative management approach.

Not all units of effort can be considered as having equal characteristics from a technical, social efficiency point of view. It is usual for vessels in a heterogenous fleet to compete for the same fish which means that each measure to be adopted should indicate who is going to be penalized and how to reach the goals, with minimum cost and damage. The economic approach allows for the group of vessels and the choice of the most efficient measure to be chosen with the lowest social and economic cost.

This leads us to examine the quality of the measures which are necessary if the fishery is to recover. If the fish are important, it is possible that generalized measures will be undertaken, but if it is the fishery as a whole which is important, then a mix of interdependent measures is needed, each one having a different impact on the fishery, in the long or in the short run, and each having a different timetable.

The contention is not that the same measure can apply equally to the whole fleet. A subsidy policy does not necessarily have the same impact if it is applied to an industrial vessel, which has alternative fishing and capital opportunities, as to an artisanal vessel, which has no alternatives. A comparison of individual yields with a given average yield for each segment of the fleet enables the specific overcapacity to be measured and allows for the right mix of measures to be undertaken to reduce it.

Even more important is the choice of *when* there is deemed to be overcapacity. In fact, since overcapacity is related to disequilibrium, it is easy to check the existence of disequilibrium by following the economic indicators of the fleet over a period of time and comparing them with the registered average value. In this case, we choose the ratio Yield/Effort (Y/E), but many others are equally suitable, depending on the quality of data available and the policy target. Any other parameter related to employment, income, investment or cost structure can be used if it is comparable and available over a long period.

It should be clear that resource exploitation is implicitly taken into account, since stocks fluctuations are readily checked by examining the variation of the vessels economic parameters around the given average Y/E.

However, what is really important is that the economic approach can more sensitively monitor the onset of disequilibrium or, when it already exists, its variations. This is possible since economists

have a wide range of alternative indicators to analyse the performance of different segments of the fleet. Cross-section and time series analyses on catch, production value, costs per unit of effort (in whatever way it may be defined) have powerful and immediate explanatory and forecasting capacity. They have nothing to do with estimates of recruitment rates, natural stock fluctuations, or natural or fishing mortality, which must be monitored.

Moreover, the Italian experience shows that biological estimates are subject to wide fluctuations, depending on which institute has carried out the research, which weights have been used to estimate the relationship between predator and prey, which parameters have been used to distinguish long-term fluctuations from short-term ones, what used estimate of environmental impact on specific resources has been used, and so on.

ECONOMIC YIELDS VERSUS PRICES AND CATCHES

It is always difficult to introduce prices into a discussion of fishery management since traditionally, economists are required only to calculate the impact that various biological measures have on the unit value of the catch, thus supporting biologists in their attitude to the management of resources. A recent example might help us to understand the problem. Since minimum permitted mesh size is one of the traditional means of preserving resources, biologists are demanding that the impact on prices of the wider mesh size should be calculated. Obviously, the implicit answer they are awaiting concerns the possibility that, in the short term, a reduced catch will produce an increase in prices, while, in the long run, after the stock has been recovered, a greater yield will raise fishermen's incomes. Unfortunately, there is no direct link between price and catch since the direction the economic yield will take depends on many independent variables which have nothing to do with production. This makes price estimates irrelevant in calculating the impact of biological measures. On the other hand, the vessels' economic yield, implicitly taking into account prices and catches, is an independent and useful parameter in terms of fishery management.

A vessel's economic yield depends on which of nine combinations of catch/price ratios will be relevant in a given fishery. Three combinations will reduce economic yields; another three will lead to an increase in the yield, and two of them will produce an uncertain situation where the direction of the yield will depend on the rate of proportionality that exists between catch and price variations. In these latter cases only demand price elasticity will enable analysts to calculate the direction of the economic yield.

CONCLUSIONS

The above analysis has shown alternative ways of managing resources, independent of the existence of reliable biological statistics.

But is it conceivable that fishery management might be independent of a more general sectoral analysis? Is it possible to think of fishery management without linking biological and economic technical measures with a more general sectoral planning? The answer is an emphatic 'no'. Other means are essential to achieve the correct ratio between resource and effort. Structural measures are an example, but financial, fiscal and social policies are even more important, and time is a decisive variable for policy-makers and public administrators.

It must be recognized that the implementation of an economic approach requires detailed and reliable data, which are not always available to demonstrate that, when it is called for, it is relatively easy to provide decision-makers with the right answers.

This is the case in Italy, where fishery economics were virtually unknown until the end of the 1970's. Today, the importance of fishery economics in the drawing up of the national fishery plan is widely recognized; — the results can be seen in the latest management plan.

It is important to stress that these results have been achieved with the full support of the fishermen, even when they have had to renounce some of their privileges, such as capital grants and subsidies on fleet investment. This demonstrates that fishermen are not always opposed to scientists, as we often hear. Perhaps it depends on which kind of science they are dealing with.

On the other hand, the results have been reached with the help of public funds. The Italian administration created a national institute for the study of the economics of fisheries.

Finally, I shall mention some ideas that the Association could well take up in the near future:

1. Data collecting enables economists to carry out work out their research and to prepare a report, in the same way as it allows biologists to calculate their estimates. Unfortunately, data collecting is expensive, so we need proper funding. It is not impossible that each administration, given a set amount of financial resources directed to fishery research, will apportion a proper share to fishery economics.

   The experience of the EC Fishery and Aquaculture Research (FAR) programme has shown that something can been done, but a lot more has still to be achieved. More specifically the establishment of a uniform range of national research stations should be organised.

2. To be effective, economists' proposals have to be based on standardized methodologies. This requires specific research directed to the uniformity of application and intrepretation of such concepts as fishing effort, overcapacity and yield.

   The measurement of the impact of EC Regulations 4028/86 and 3944/90 on European fisheries could present an opportunity to implement points 1 and 2 above. European Community and by individual member states Planning and Organising by the could lead to proper funding for these ideas.

These are only two suggestions. Many others will be added during our discussions, but possibilities of success will depend on the strength our Association can achieve, and thus on the amont of support that each one of us can give it.

Regional Disparities in the Fishing Activities of the European Atlantic Regions

by

Jean-Pierre Boude

Ecole Nationale Superieure Agronomique de Rennes (ENSAR), Rennes, France

ABSTRACT

This paper examines the principal characteristics of the European fisheries in the Atlantic between the south of Spain and Scotland. The survey was conducted in fourteen regions. In the first part, the data are analysed. The indicators that have been retained are: number of fishing boats, power, Gross Registered Tonnes (GRT), number of fishermen,volume and value of catches, main species caught, average landing prices, ratios for return on capital, labour productivity, landing concentration indice; indicators concerning the downstream of fishing activities have been devised. This initial approach enables the comparative and competitive assets of each region to be assessed. An analysis of the hierarchical ranking confirms that no clear-cut typology emerges. In the second part, two methods of analysis are presented. One is an analysis of market chains (filière) with application to a french region, the second is the productivity surplus account method. The analysis of regional data concerning fishing activities shows that opposition between northern and southern Europe gives a reduced picture of the fishing reality in the European regions.

INTRODUCTION

The significant imbalance that exists within the European Community between the size of the EC fishing fleet and the resources available to it requires that structural measures be introduced. If these were adopted, present discrepancies should be greatly reduced.

In the mid-term, these measures should not only allow the fisheries' to become profitable again but should also allow downstream and upstream sectors to be maintained.

Recent measures intended to reduce fishing effort imply that there will be a decrease in the volume of employment, leading to considerable economic effects both downstream and upstream of the fishing industry, but it is extremely difficult to forecast what these effects will be, and where they will have the most impact.

Since it is probably illusory to try to forecast the social and economic impacts of a reduction in the fishing effort — both at European and national level — it is rather tempting to ask whether a regional survey could provide a criteria for comparing Europe's Atlantic regions which would allow for a fuller and deeper analysis of the issue. It is also important to ask how we can devise a methodology for solving these problems.

ANALYSIS OF REGIONAL DISPARITIES

The survey was conducted in fourteen regions in what is known as the Atlantic Arc, an area that stretches from southern Spain to Scotland. Due to weaknesses in statistical information and a similarity in most essential parameters in both countries, it was decided to merge regional data from Portugal and the Republic of Ireland in order to obtain homogeneous data,. It is obvious that the size of the observed entity will affect the level of results.

A number of indices has been used, the most significant of which is based on data that can be obtained in a standard way, although several assessments have been necessary: number of fishing boats, horsepower, tonnage, number of fishermen, volume and value of catches, and main species caught (volume and value). The most significant computed ratios have been average landing price, ratios for the return on capital and labour productivity, average value per horsepower, per GRT (Gross Registered Ton), per ship and per fisherman also landing concentration indices. A number of indices downstream from the fishing activity has been developed, but these have not been included in the data analysis because regionalization under the same geographical criteria was not possible. These indices concerned added value of the processing industry, number of employees, investment rate and foreign trade. All were used as *a posteriori* explanatory factors.

The first data analysis brought to light a certain number of factors, taking into account common points and disparities between regions. This allowed the analysis to highlight the most prominent regions; the Northwest Spainish region, Scotland and Brittany together land 60% of catch volume in its region and 54% of its values. Several areas appear to be very specialized (more than 50% of the total value are for only three species) and include Poitou-Charentes, Northern Ireland, the Cantabrian region, and Scotland. This indicates how important any decrease in landing if any of the target species may be for these regions. It should be noted that the quasi totality of the main catches of fish in each of the regions is subject to Total Allowable Catches (TAC).

An analysis of average prices showed the significance of areas such as the Spanish South Atlantic region and, to a lesser degree, the Cantabrian region, Brittany, England south-west and Wales.

The analysis of production factors shows the typical disparities that exist between the Iberian regions and the others. Spanish and Portuguese regions have 46% of the total catches and 50% of the values of the fisheries, 70% of the Gross Registered Tonnage (GRT), 52% of the horsepower and 75% of the fishermen.

On the other hand, an examination of productivity and value ratios points to high performance levels in northwest Spain, Brittany and Scotland.

This initial analysis has allowed us to bring out the comparative and competitive assets of each region, but no clear-cut criteria have emerged.

An analysis of the hierarchical ranking[1] yielded a dendrogram tree which allows similar regions to be grouped together. Such groupings are all the more homogeneous since the 'knot' at the level of which grouping is made has a low inertia index.

Three levels can be distinguished in the dendrogram. The various classes are characterized by the type of variable which has been used along with its value.

The first level (N1) is generated essentially by catches per GRT and the weight of the Poitou-Charentes region which features a strong oyster-producing industry.

In the second level (N2), representing non-homogeneous classes, wide disparities exist, depending on the data: the Scotland-Brittany-Ireland agglomeration, and the northwest Spain-Portugal agglomeration. The levels of aggregation are very high, and the significance of different knots is not very clear (high inertia index > 2,5).

The third level (N3) represents homogeneous classes grouped into four categories:

- —Scotland and Brittany both have high landed volumes per fisherman, as well as high volumes and horsepower.
- —the Cantabrian region and Southern Spain Atlantic have high numbers of fishermen and low landed volumes.
- —Northern Ireland, southwest England and Wales are similar in many repects.
- —Lower Normandy, Pays de la Loire and Aquitaine have a low number of fishermen as well as similar economies, at least as far as Pays de la Loire and Aquitaine are concerned.

[1] The hierarchical ranking analysis is an automatic method of analysing of data. The principle is to build a series of partitions of n ranks, n-1 ranks,n-2 ranks, n-3 ranks fitted into one another. The partition into x ranks is obtained by linking two ranks of the partition in the x+1 ranks.The partition in one rank is the set of all constituents. Each partition is included in a following rank. The higher the level of the rank indice the more heterogeneous is the set constituted; this index is the 'aggregation level'. In our presentation, the y axes represent this aggregation level. The knots from 15 to 27 represent the successive links in this scale of aggregation level. N3, N2, N1 represent three significative levels to obtain different sets. For example, N3 determines A, 2, B, 5, 14 sets; N2; determines A1, A3, 2.4, 2.5, B3, B4, 5.12, 5.13, 14 sets and so on.

If we leave aside the North-South contrast regarding the volume of factors of production, when we take into account the structural features of landings — and especially efficiency ratios — the criteria are no longer very clear. It would be illusory to draw up a regional classification without carrying out a more detailed analysis. Geographical areas are extremely diverse and only an analysis performed for each region would allow us to predict the results of any structural measure. Only a trade by trade (one type of boat, one or several types of targets, one type of fishing tool) and fishing fleet by fishing fleet economic analysis would highlight clear factors showing common characteristics among regions.

AN ANALYSIS INTEGRATING ALL THE DYNAMIC ASPECTS OF THE DIFFERENT SECTORS

It therefore seems to be necessary to analyse those economic effects induced by the European structural measures, using sharply defined observation units as a support.

The first method consists of making sectoral analyses, a sector being defined as a set of articulated economic agents, with the outputs of one agent representing the inputs of the next one. When correctly carried out, this approach reveals the development or impediment factors, both at structural and strategic levels, for each level of the sector, as well as for the whole sector. To assess correctly the different upstream and downstream fluxes makes it possible to determine the employment and income multipliers for the sector.

The use of this method in 1986 enabled us to work out that, for the Lower Normandy region, one seafishing job generated 1.18 land-based jobs, including 0.77 jobs upstream and 0.15 jobs downstream; the remainder were training and supervisory jobs. This method also showed that one French franc of landed fish in the region induced FF 1.30 upstream and FF 0.93 downstream, that is to say FF 2.16 in total, with the region directly benefitting by FF 1.40.

This approach helps to identify the economic effects induced by any structural measure, provided that effects on landing volumes and values are already known. It also makes it easier to see which support measures should be implemented so that structural measures can be made more efficient.

Such an analysis is inadequate since it does not take into account the possible evolutions regarding the formation of productivity gains or losses by production units. In particular, any structural measure may entail modifications in the production function which counteract the desired effects (e.g. capital-labour substitution in the fishing sector or the introduction of technical progress).

Besides analysing these modifications, researchers could employ the productivity surplus account method. This method is rather delicate to implement since it implies that, using from the ship's accountancy data, we can accurately calculate a dissociation between product quantities and values, and factors of production. Nevertheless, this method has been tried on an experimental basis, with a simplified implementation, in the fishing sector.

Firstly, the formation of the productivity surplus (gain or loss) has been computed in order to highlight how many factors or products participate in this formation.

Secondly, without establishing a direct link with the previous stage, it is possible to compute the 'distribution' of this production surplus among the various agents that are linked to the ships. These agents are the financiers, suppliers, customers, fishermen and skippers.

It is then easy to draw a balanced account which reveals the partners who contribute to the constitution of these surpluses, and those who benefit from the shared-out advantages.

If the surplus account yields information about the efficiency of a better method of implementating the factors of production, it also brings to light the efficiency of the firm's strengths through its relationship with its environment. This allows a dynamic analysis to be carried out. If a classification of trades or fishing fleets exists, the relevance of such an approach is obvious since, with correct sampling of earnings reports, it is possible to know the effects of modifications in ship productivity levels and the consequences induced of these modifications.

c

The analysis of regional data concerning fishing activities shows that opposition between northern and southern Europe gives a reduced picture of fishing in the European Atlantic regions. The diversity of fishing activity in these areas cannot be denied. It explains the frequent conflict between fishermen, in whose better interests it would be to act more like partners.

The development of regional fishing activities cannot be dissociated from that of the other sectors. A better processing and value adding may lead to an improved economic situation for everyone, including the fishermen. Within the framework of increasing internationalization, it would be detrimental to the fishermen if production units became even more remote from local fishing activities. In the long term, this inevitably would entail both a delocalization of these units and all the economic and social effects which are often linked to this type of phenomenon.

Only the implementation of methodologies that take into account all aspects of the situation (analysis of data, analysis of the upstream and downstream economic effects induced by fishing activities, analysis of modifications in productivity) will enable us to determine the consequences of any structural measure and so to define economic and social support measures. But this would serve no purpose if a large training effort were not quickly achieved at the same time: misunderstood measures are less efficient and also entail numerous unexpected side-effects.

TABLE 1

Data of the fishing activities of the European Atlantic Regions

Regions	Catches (mt)	Value (ecu)	Ships (number)	G.R.T.	Power (Kw)	Fishermen
Scotland	554,910	380,916,695	2,334	72,345	352,493	8,711
Wales	7,636	9,006,162	415	7,332	35,724	955
South-West England	47,497	61,014,338	971	17,155	83,586	2,235
Northern Ireland	22,566	23,456,055	358	15,646	76,234	1,251
Republic of Ireland	217,039	90,502,289	1,150	29,700	212,260	7,750
Lower Normandy	71,661	93,342,079	974	11,802	82,453	1,476
Brittany	341,417	466,463,677	2,942	104,024	456,123	6,503
Pays de Loire	53,758	110,384,528	1,134	13,112	111,553	2,186
Poitou-Charentes	87,897	176,818,358	360	6,287	40,311	2,710
Aquitaine	22,650	51,570,612	518	13,186	67,104	1,210
Cantabria	114,000	211,714,479	2,473	130,743	358,773	15,207
North-west Spain	608,800	695,034,247	5,553	257,616	619,125	30,641
South-west Spain	111,400	330,253,367	1,696	102,639	297,349	13,845
Portugal	225,000	158,356,748	7,268	199,501	354,986	43,111
Total Atlantic Arc	2, 486,231	2,858,833,634	28,146	981,088	3,148,074	137,791
Total E.C.	6,850,000	5,887,000,000	102,699	1,948,903	7,967,042	299,316
Total France	577,383	898,579,254	5,928	148,411	757,544	14,085
Total Spain	834,200	1,237,002,093	9,722	490,998	1,275,247	59,693
Total U.K.	632,609	474,393,250	4,078	112,478	548,037	13,152

TABLE 2

Diagram of a Surplus Account

SUM OF GRANTED ADVANTAGES (A)	=	GLOBAL PRODUCTIVITY SURPLUS (SPG)	+	GAIN OF SURPLUS .
		(S	T	D)

SURPLUS ACCOUNT	
SUM OF GRANTED ADVANTAGES (A)	*TOTAL AVAILABLE SURPLUS (STD)*
TOWARD BUYERS ($-\Delta p_i$) TOWARD CONTRIBUTERS OF PRODUCTION FACTORS ($+\Delta f_j$) . FISHERMEN . SUPPLIERS . MONEY-LENDERS . STATE TOWARD SHIP OWNERS ($+\Delta B$)	GLOBAL PRODUCTIVITY SURPLUS (SPG) EXTERNAL GAIN OF SURPLUS . FROM BUYERS ($+\Delta p_i$) (PRICE INCREASE) . FROM SUPPLIERS ($-\Delta f_j$) (REMUNERATION DROPS) . FROM SHIP OWNERS ($-\Delta B$) (BENEFITS DROPS)

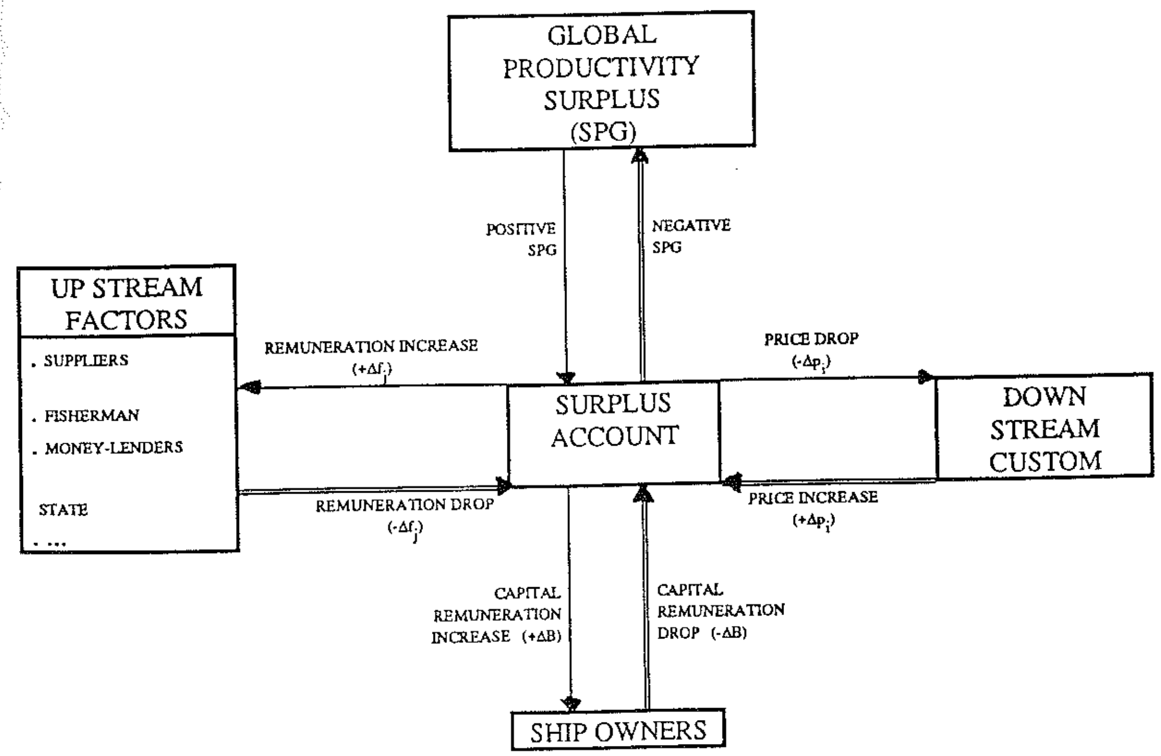


TABLE 3

Hierarchial Ranking Analysis

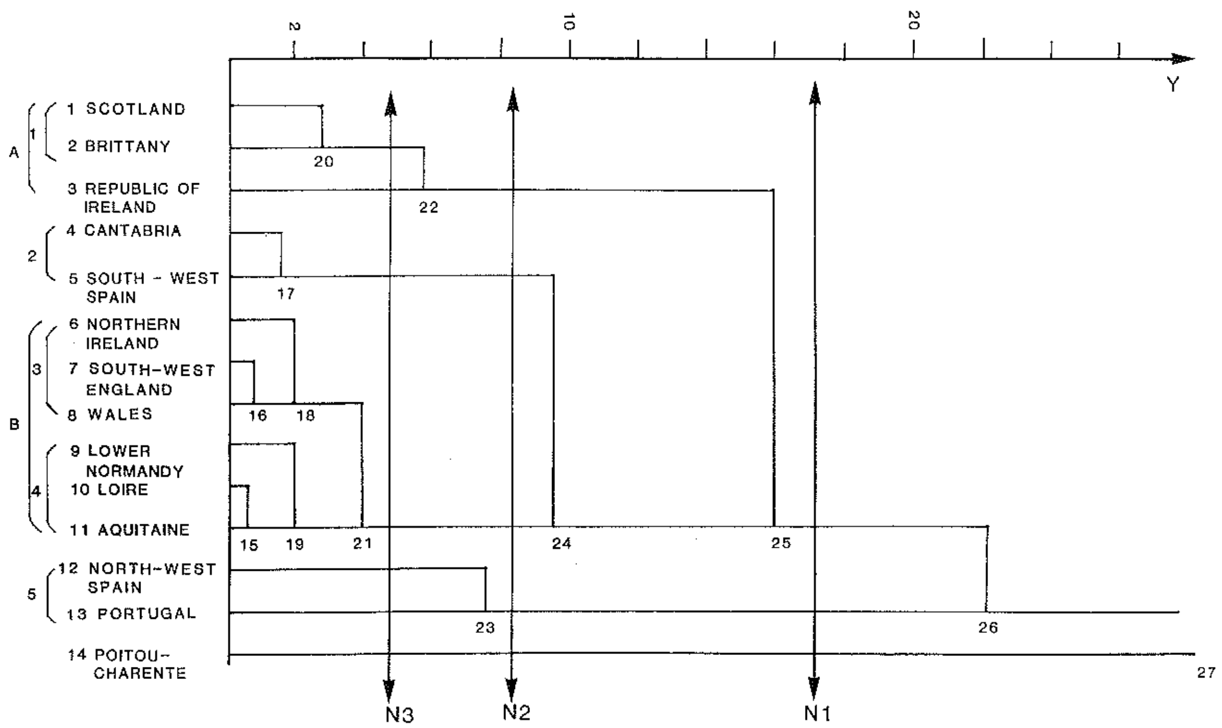


Figure 1

Catches per Area

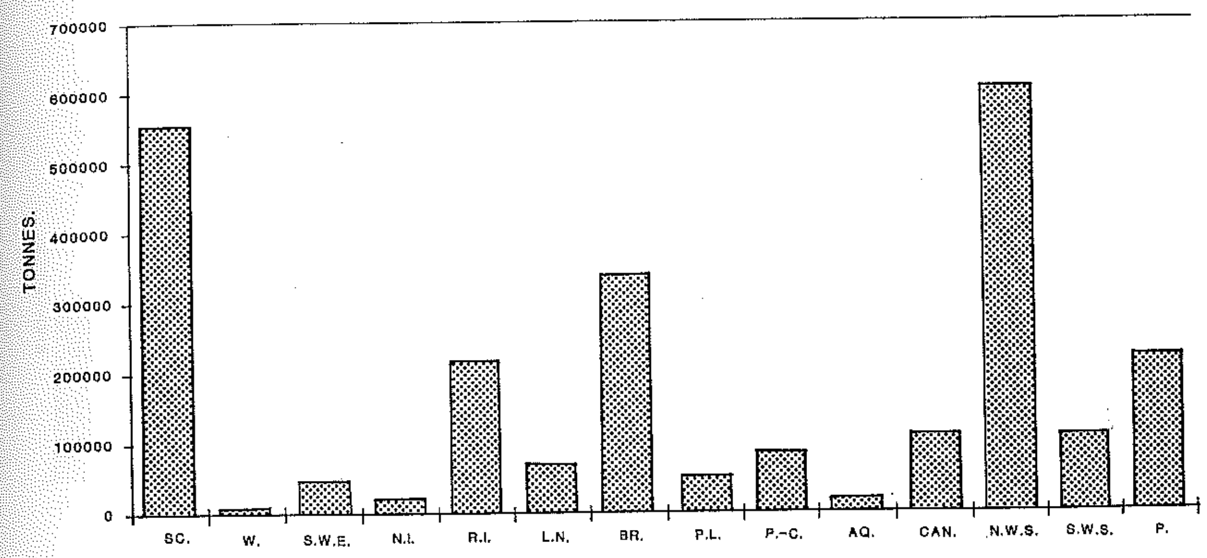


Figure 2

Value of Landings per Area (ECUs)

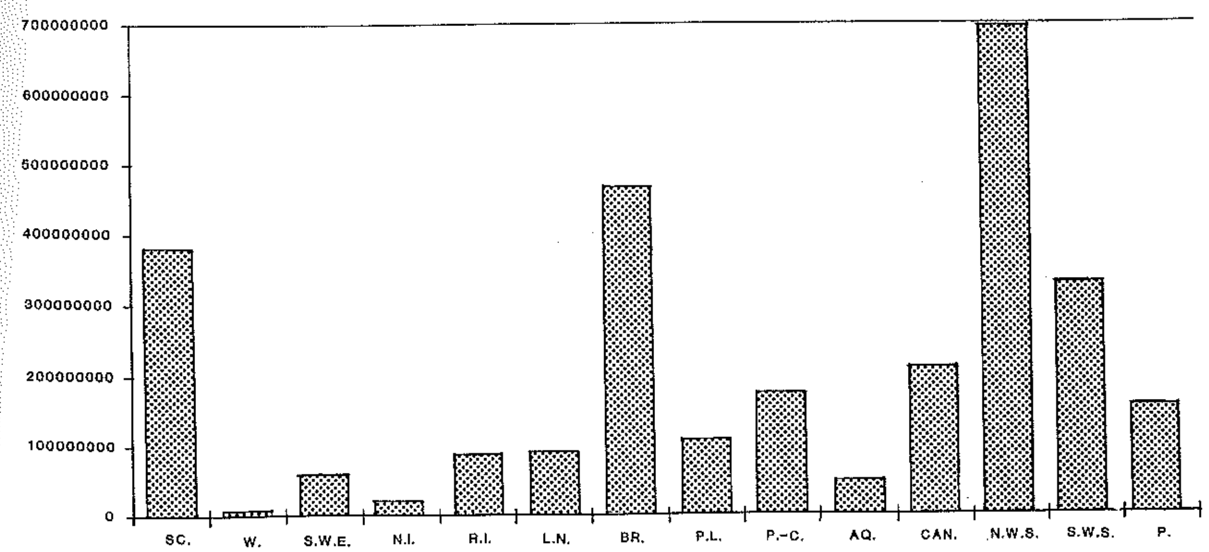


Figure 3

Average Prices per Metric Tons

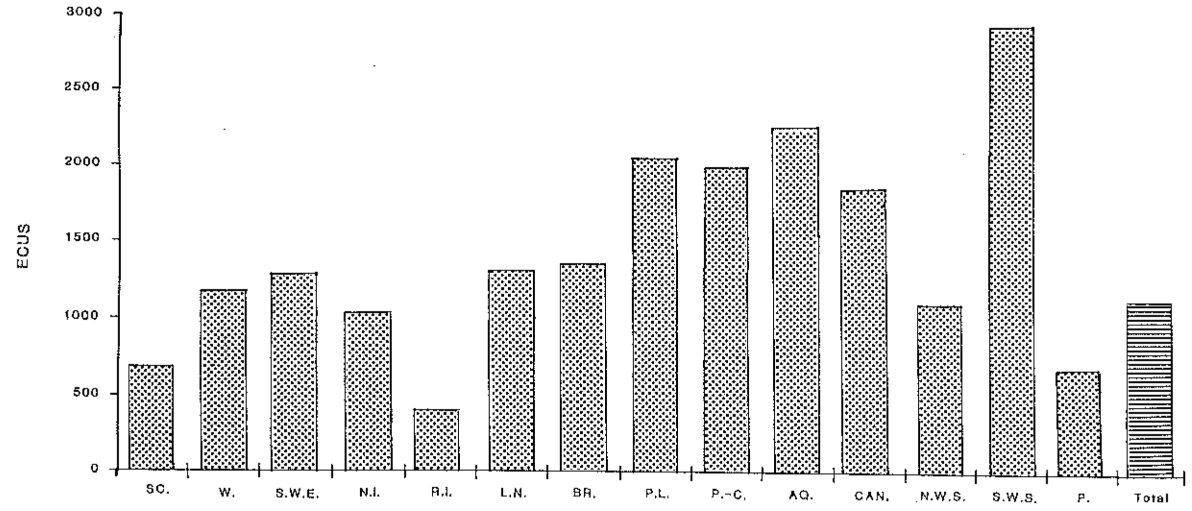


Figure 4

Average Power per Fishing Vessel

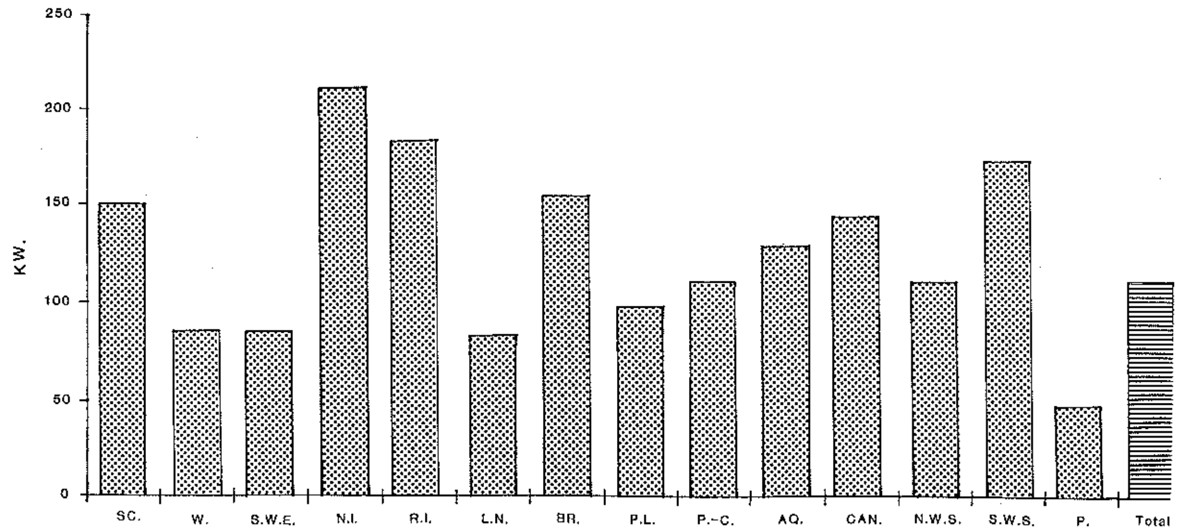


Figure 5

Number of Fishermen per Area

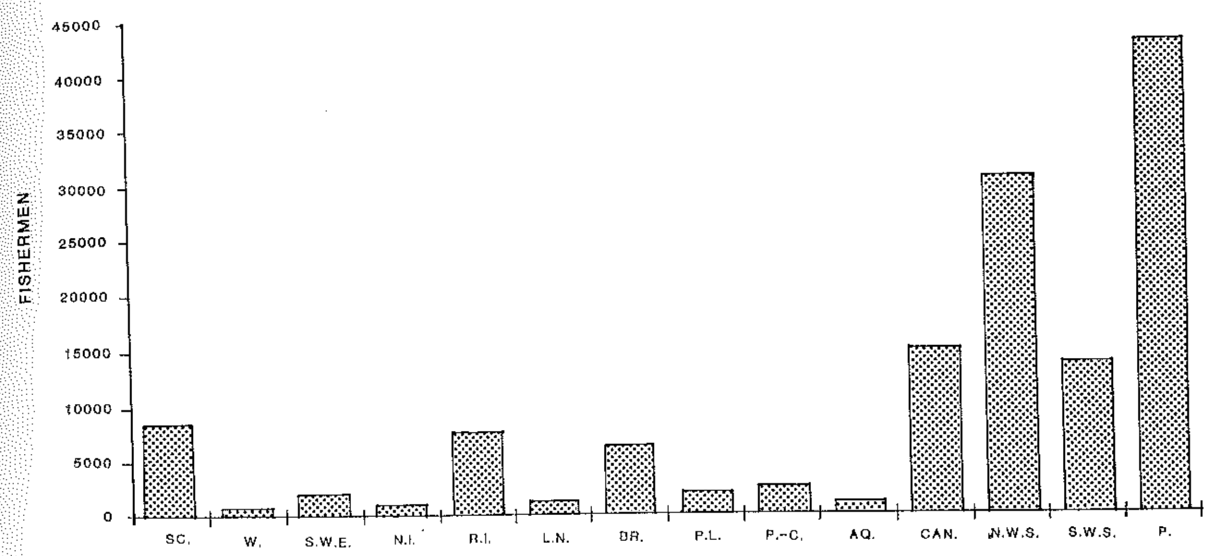


Figure 6

Number of Fishermen per Fishing Vessel

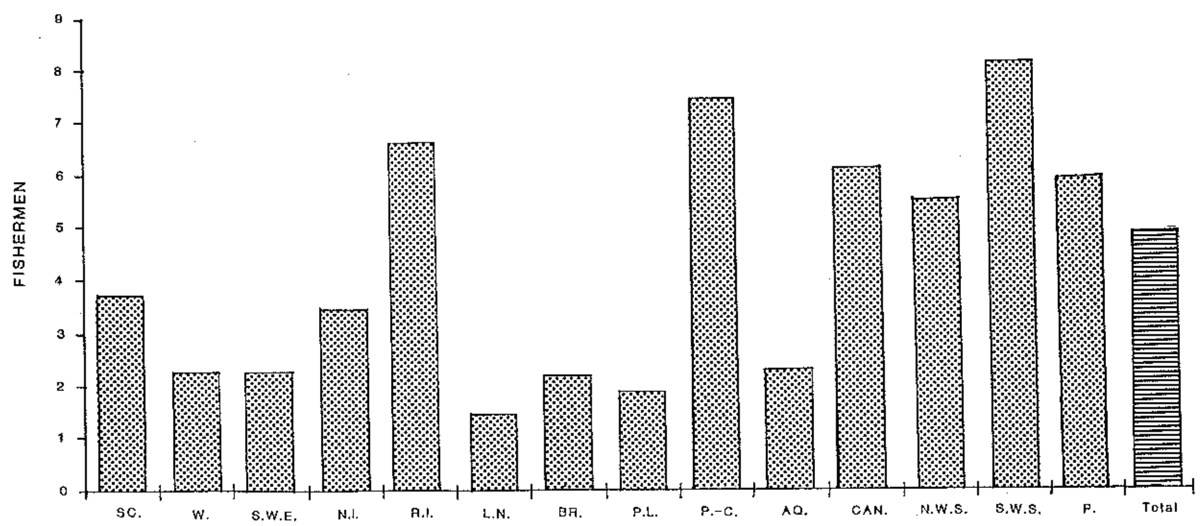


Figure 7

Catches per Fishing Vessel

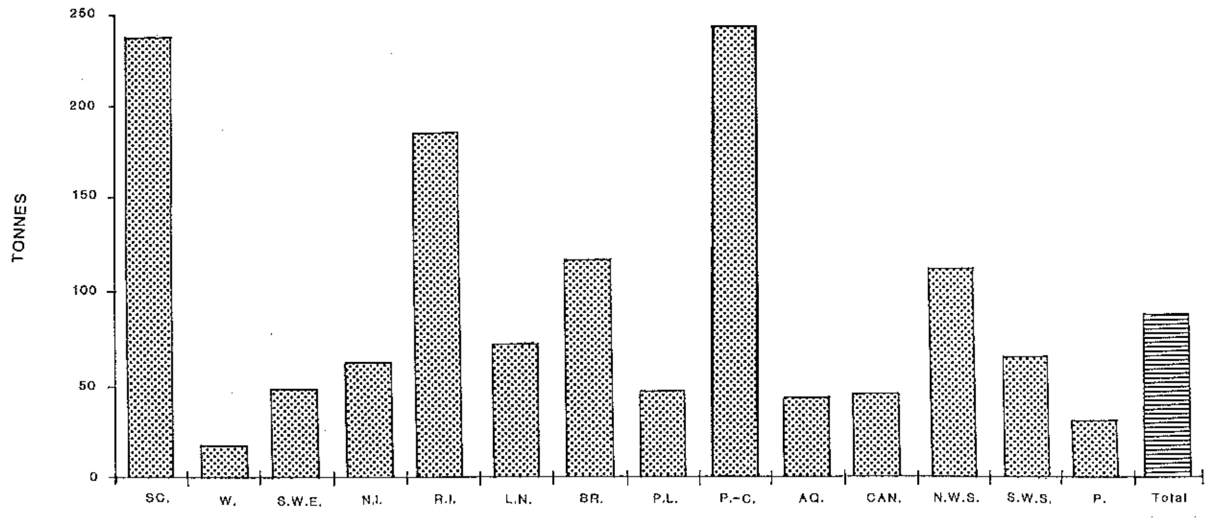


Figure 8

Catches per Kilowatt

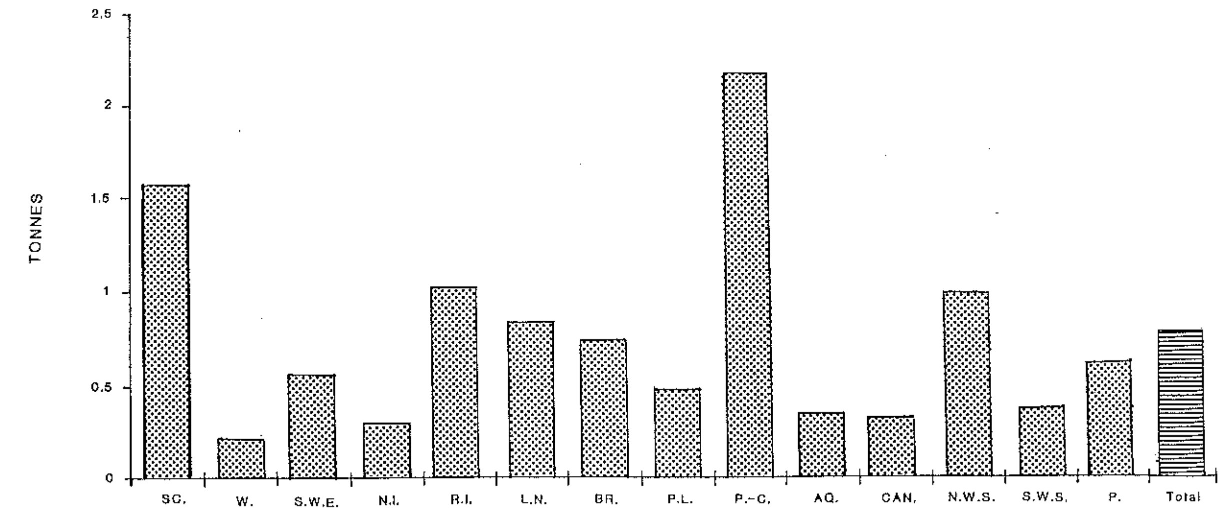


Figure 9

Catches per Fisherman

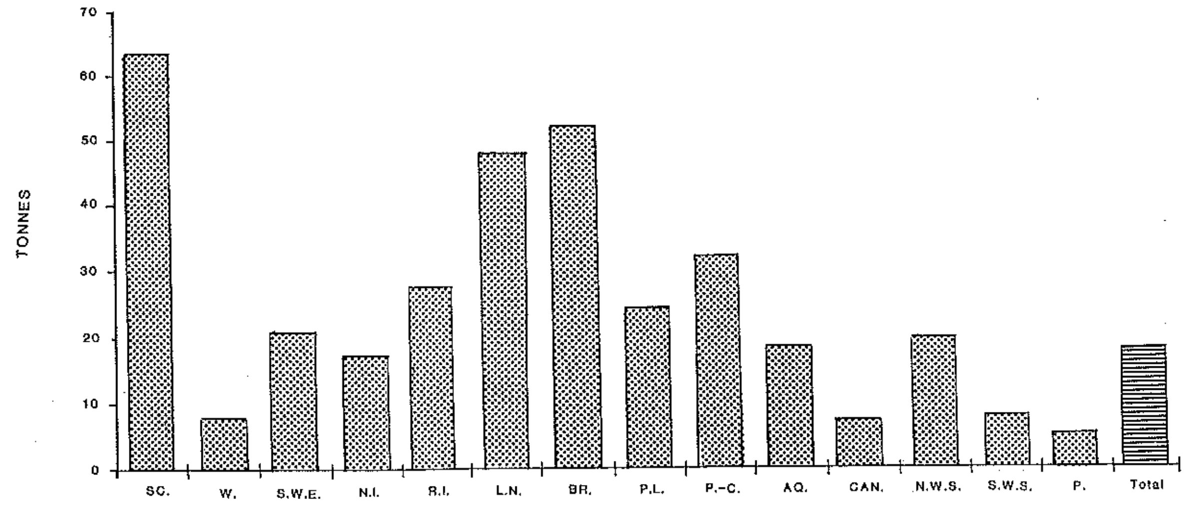


Figure 10

Value of Catches per Vessel

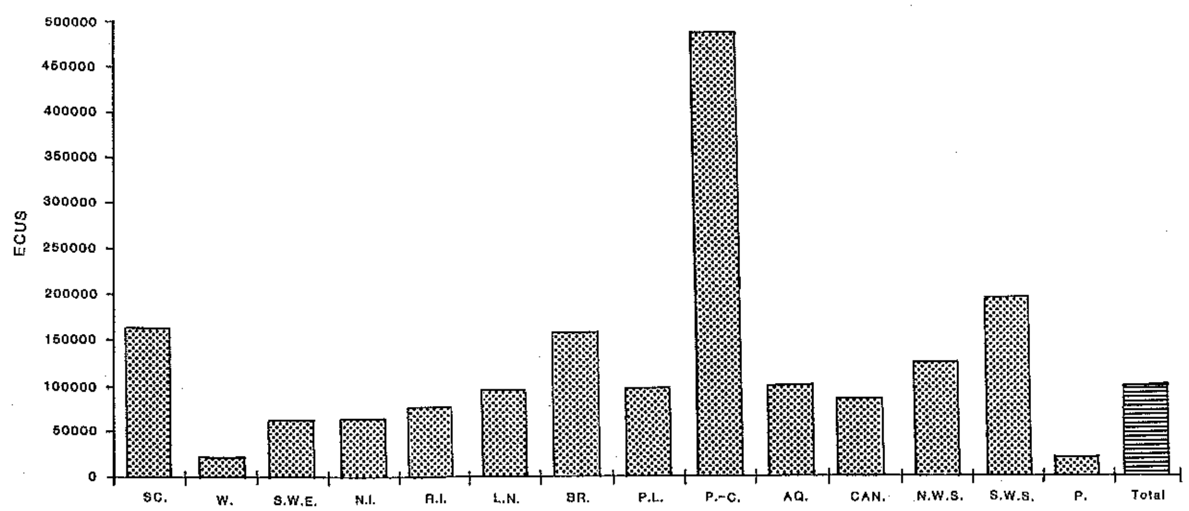


Figure 11

Value of Catches per Kilowatt

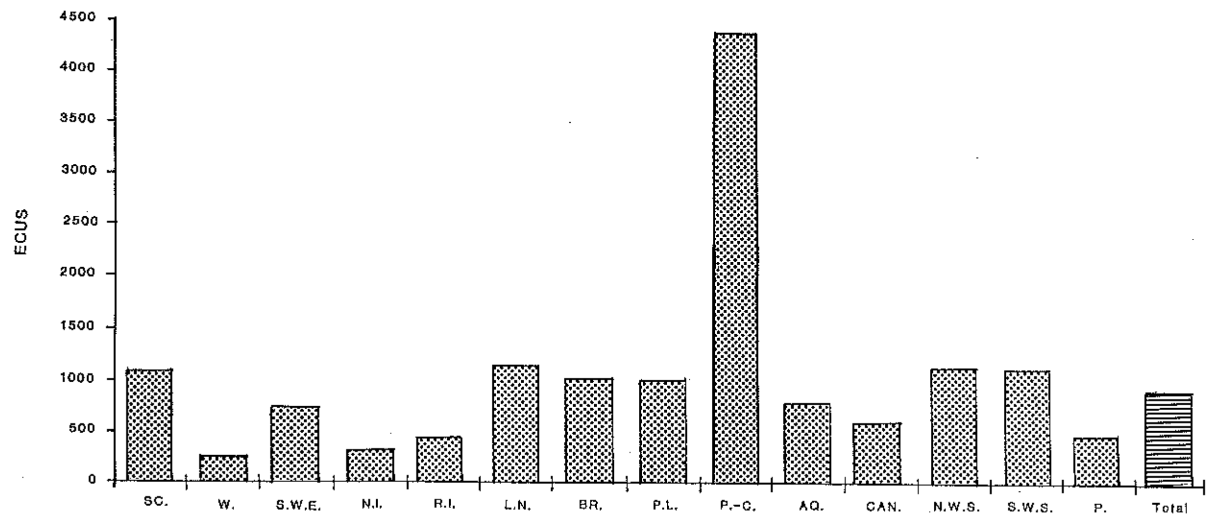
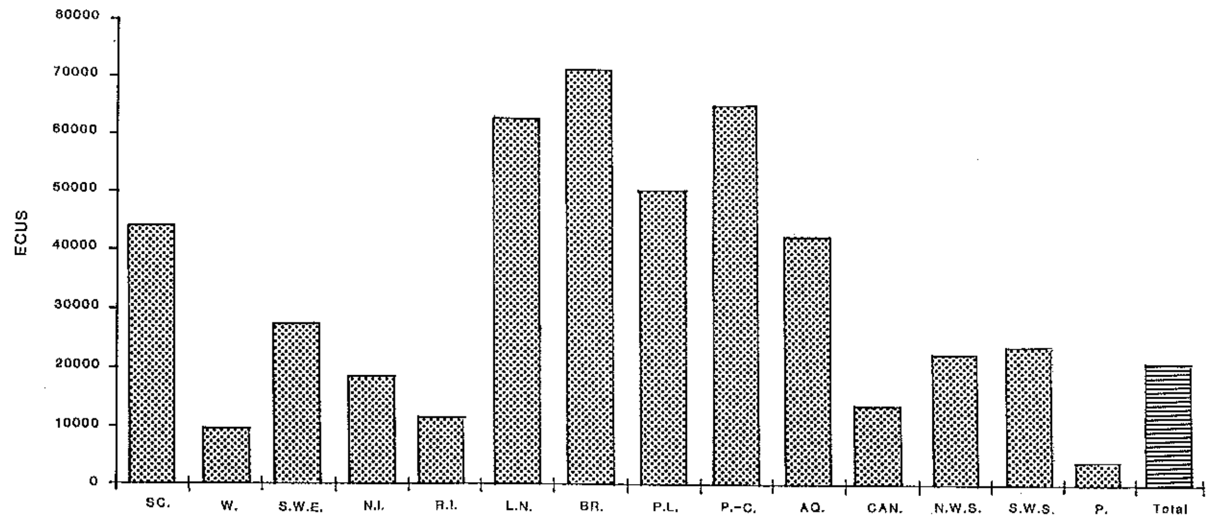


Figure 12

Value of Catches per Fisherman



Fisheries Economics is a Special Kind of Economics

by

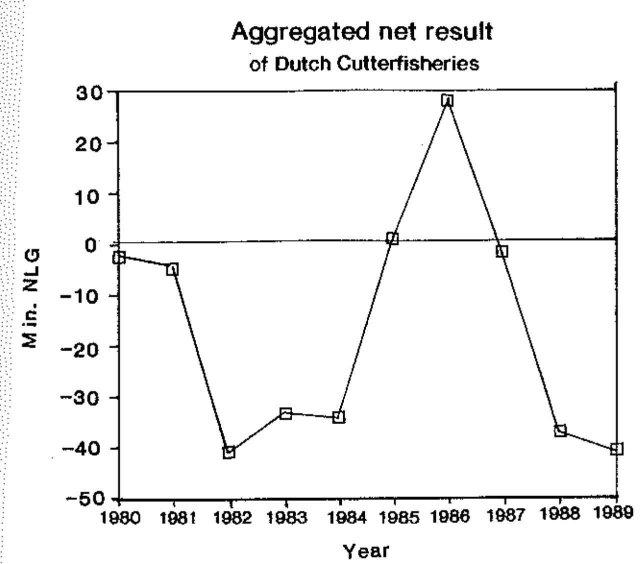
WIM DAVIDSE

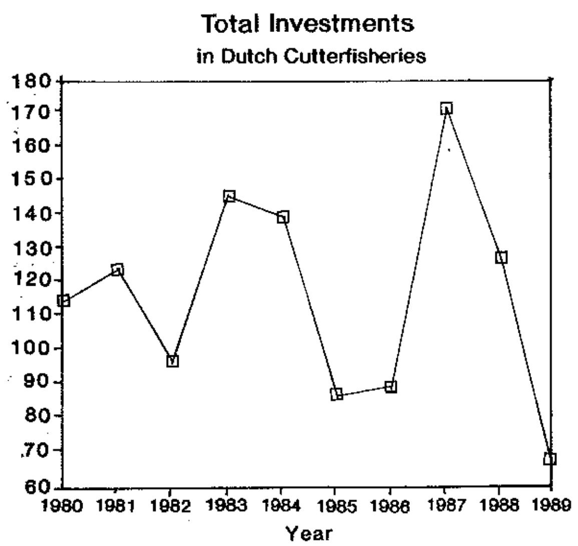
Agricultural Economics Research Institute (LEI), The Hague, Netherlands

In this paper the readers attention is drawn to the fact that a major expansion may occur in a fishery suffering net losses over many years. How can this be explained and what are the consequences of this phenomenon for the management of fishing capacity?

For many years the costs and earnings have been calculated for Dutch cutter fisheries. In eight of the past ten years net losses occurred; one year showed a break-even situation and only one year (1986) was profitable. Nevertheless, investment activities were at a high level in most years, resulting in a rise of fishing capacity in terms of horsepower with nearly 50 % from 1980 to 1989.

Average horsepower per vessel rose from 725 hp in 1980 to 1000 hp in 1989.





Such a development is at odds with economic theory. It is impossible for enterprises to expand when there are continuing losses. An average return on investment (ROI) of 2-3%, the level in the Dutch cutter fisheries, is too low for an enterprise to survive in the long run; expansion in this case seems to be a wonder. How can this be explained? Were the calculation methods wrong, or did the fishermen not act in accordance with the theory?

FINANCING NEW VESSELS

LEI work generally accepts standard accounting principles:

- Depreciation of the ships is based upon the replacement value so that rising prices for new cutters lead to higher depreciation.
- All costs of production factors are calculated, like a renumeration for the owner and full interest costs for the invested capital.

There was one phenomenon which upset the calculations: ships replaced by new ones were sold at prices which far exceeded the book-values of the old ships. The selling price of a six-to-eight-year-old cutter often was at the same level as the original investment. A typical and actual example shows how a new ship could be financed though depreciations that was not fully earned due to losses.

Finance of a new cutter

	NLG
Selling price old cutter	1,800,000
Redemption of remaining debt	550,000
Financial means for new cutter	1,250,000
Finance from exploitation in 7 years:	
• Savings	−490,000
• Depreciation	+900,000
• Redemptions of debts	−435,000
Total	−25,000
Investment premium new ship[1]	540,000
Total of self-generated finance	1,765,000
Building costs of new ship	4,500,000
Contribution of own capital: nearly 40% of total finance	

[1] Premium for all investments, not only in fisheries. Not in force now.

From the fiscal point of view, the results in seven years of operation would be less unfavourable because of lower depreciations and lower amounts for labour and interest (no costs for the owner).

So the high prices which the investors received for their 'old' ships were the most important source of finance for the new ones, thus partially explaining the high level of investment in a situation of net losses.

The conclusion is that fishery economics have special features, especially with regard to profit calculations. This suggests that commonly practiced accountancy rules should be re-examined. This reflection upon methods calculating of profit may take place within the EAFE, especially within a common project of four institutes. This refers to a cost and earnings study for North Sea Fisheries as one of the EC FAR projects, which started in April 1991.

FAMILY ENTERPRISES

Another explanation for the survival and even expansion at a very low rate of return of the fishery has to be sought in the decisions of the fishermen. Their decisions differ from the decisions of the supplier of capital, upon which most economic theories are based. Theories about investment selection, the valuation of the company's assests, profit calculation were mainly formulated from the point of view of the shareholder/owner, who wants a maximum profit and a maximum return on invested capital.

That is not however the attitude of the fishermen. Except for the industrial fisheries, like distant water fisheries the enterprises of the fishermen are family enterprises. This means that the continuation of their existence as independant fishermen/ vessel owner's and the transfer of their business to their children and grandchildren is a more important incentive than profit maximization. Even maximization of their status within the local community may be a more important goal than profit maximization.

We can see that fishermen in the Dutch cutter fisheries are able to continue their enterprise at a very low or even negative rate of return on capital. This refers especially to the fishermen who bought the very expensive second-hand ships and the 'non-investors'. The fishermen do not require the full interest on their equity and are able to remain in the fishery as long as their debts can be repaid.

This can be illustrated by a remarkable development in the period 1980-1984, when each year a substantial net loss occurred for the cutter fisheries. Nevertheless, the number of vessels increased in this period from 535 to 611.

The family enterprises in other EC fisheries probably show the same characteristics as the Dutch ones. In agriculture, too, family enterprises survive even when net losses dominate. In fact, Dutch agriculture would be impossible if the volume of labour had to be paid in accordance with the wages in industry and if the owners required the usual return on their money.

What is the consequence of the special economy of family enterprises for the management of fishing capacity?

- Ambitious programs for fleet reduction may fail. Family enterprises have the capacity to survive bad economic circumstances. Fishermen may prefer to continue their enterprise, accepting a very low remuneration for their labour and capital, rather than benefitting from decommissioning schemes.
- If fleets can be reduced a limited number of fishing enterprises would enjoy rather high profits in a protected industry. The position of the remaining enterprises would be quite different from that in the past with free competition as a main characteristic.

In fact management of fishing capacity requires a sharp definition of its main goal; with respect to the Common Fisheries Policy, a choice has to be made between a fishing capacity at the level needed to fish the TACs, thus creating a limited number of enterprises with a high level of return on investment, and a greater number of enterprises operating under sub-optimal economic conditions. In the latter case, the real fishing effort should be lowered by regulation such as a maximum number of days at sea. Such a situation would be more in accordance with developments in the past, when profitability used to be rather low.

The main goal of a skipper/owner is not only profit maximization. Remaining in the fishery sector, being a fisherman, is at least of equal importance. Therefore I shall conclude by asserting that fisheries-economics is socio-economics!

A Further Contribution to the Individual Boat Quota (IBQ) Debate

by

J.P. Hillis

Fisheries Research Centre, Dublin, Ireland

It is by now widely accepted that optimal levels of fishing effort lie far below those currently existing in the great majority of European Fisheries. On the Beverton and Holt (1957) yield per recruit function used as a standard part of preparation of management advice by the ICES working groups. effort yielding optimal catches (the 'F max' value) is normally well below that current and taking as standard the approximate percentages of revenue accounted for by fixed costs (25%) variable costs (25%) and share wages plus profit (50%) reported by David and Banks (1985) and O'Connor et al (1980), it has been shown that the profit obtainable from a fishery at optimal effort is much greater than current profit Figure 1 (Hillis, 1990a, 1990b, 1990c). Furthermore using these cost and profit ratios on available yield per recruit curves (ICES Working Group Reports) shows that for Irish interest fisheries, optimal effort can be low as 23% of current effort (Irish Sea Whiting) and maximal crew shares plus profit is slightly greater for whole fishery of the manning level of the fleet is reduced commensurably with the number of boats to the minimum necessary to take optimal catch, then with increased fleet profit divided among a much reduced labour force, increases of up to about 800% with some species can be envisaged.

Methods of protecting fish stock have been enumerated by Cunningham, Dunne and Whitmarsh (1985) among others. Measures so far in the European Community have included the traditional ones of minimum mesh and minimum landing size plus Stock TAC's divided into national quotas since 1982. Since these measures have proved relatively disappointing in their capacity to rehabilitate stocks, the introduction of further measures has been proposed, such as the Multi-Annual Guidance Programme (MAGP) requiring member states to reduce fleet capacity. The situation now is that most exploited stocks are enfeebled, such conservation measures as have been applied not having succeeded very well in improving their condition. There are signs that some managers would like to solve the problem by reducing fleets to such an extent that they could not physically overfish significantly. This appears to be the basis of the warning by EC Commissioner Marin of his belief in the need for a 40% average reduction in fleet capacity (Harney, 1990) and the call by Michael Holden (1991) since his retirement from the EC Commission for TACs to be replaced by a licensing system under which fleet sizes would be reduced to levels too low to significantly overfish the stocks.

The problem is that to access maximum long-term (equilibrium) profits requires such a reduction in effort that the distribution of the ensuing elevate provides the classic economic efficiency versus equity dilemma. For example, with Irish Sea cod, 75% reduction in effort, will eventually yield 91% increase in the total fishery crew shares plus profit, with fleet size unchanged, which of course entails an average rise of 91% in income to all of the labour force of unchanged numbers; the boats however would be tied up for 75% of the time, and would be retained in unchanged numbers mainly to guarantee jobs to the existing number of crews. With reduced fleet size to that needed to exercise 25% of the original effort (i.e. reduced by 75%) one has to envisage each boat with its original crew multiplied by 4 maintain job levels, which would be complicated but would yield an average increase in income of 125% (i.e. multiply incomes by 2.25). Should the labour force be reduced commensurably with fleet sixe, the overall original profit × 2.25 would not be shared by merely 25% of the number of the former labour force, so individual incomes in the surviving labour force would be 9 times higher than their original level. Other fish species show changes along the same lines — of the labour force is cut to that commensurate with taking the optimal catch, the considerably increased overall profit will be divided amongst a considerably reduced number of fishermen, resulting in spectacular increase in individual income, especially amongst gadoid (cod, haddock etc.), fishermen. The classic efficient economic solution is to advocate such reduction of the fleet followed by taxation of the incomes to remover the "supernormal" element in the profit. "The unpopularity of such measures requires no comment" (Clark, 1985), but is to be appreciated that fishermen might well be better off paying a tax/fee for trespassers/poachers to be kept away from their stocks than they would be if they did not have such a service.

The fact that member states of the EC on the mainland of Europe have been given decommissioning schemes with scrapping grants 50% funded by the EC has led a number of British sources to imply that they have a "right" to a decommissioning scheme. The fact is that a decommissioning scheme will help the fishermen and it will help boatyards more (where employment is bound to shrink if fleet size is reduced) but in the long term it will only help fishermen of one generation and their offspring will find it an industry well nigh impossible to enter for employment.

It thus might well be much less costly to design a system to reduce fishing hours but not immediately fleet size, and to pay (i) to compensation for losses in catches and (ii) for a surveillance force to ensure compliance with the rules, allowing boats (subject to observation of safety criteria) to reach the ends of their normal working lives before being scrapped, a point also made by Anderson (1986). Methods should also at least be considered of retaining the labour force size at level near its current on the grounds that a rehabilitated fisheries should provide enough income to support them at a higher level than is possible at present, and also yield/tax revenue to pay for collection of the large amount of information necessary to ensure that an effort reduction scheme without fleet minimisation (tie up or individual quota) is being implanted according to plan.

It is interesting to note that whereas outside Europe some progress has been made with Individual Transferable Quotas leading to increased profit and fleet reduction (Clark et al, 2989, Piner and Huston 1990) in Europe, the emphasis has been on the allocation of national quota to boats within the EC TAC and quota system, with little or no transferability (Salz 1990). In Iceland, after 10-15 years of individual boat quotas with transferability very strictly controlled, the industry is now moving towards a pure Individual Transferable Quota (Arnason 1990); Iceland however has no significant unemployment problem In the United Kingdom, a potential basis for orderly reduction of effort with minimum job losses exists in the arrangement of the Anglo-Scottish fish Producers' Organisation centred at Berwick-on-Tweed, where the PO's quota is allocated to boats on the basis of the numbers of men employed in the crew. This appears to be a very forward seeing arrangement.

There are of course a number of others to be considered, such as (i) the problems of guiding the industry through periods of initial loss when effort reduction measures are first applied (ii) the exhaustion of quota for one but not all species caught in a mixed fishery, (iii) fluctuation in abundance of stocks and (iv) excessive discarding at sea to upgrade the size of fish comprising the landed catch. The second may probably best be solved by a carefully calculated system of inter species transferability of quotas so designed that if one species is conserved to a lesser extent than originally intended, then compensation is exercised by another species are being conserved to a great extent. Fluctuation in abundance are best catered for by basing quotas on percentages of TAC rather than on a fixed volume. To combat excessive discarding at sea, it might be most effective to consider the Norwegian system of banning discards; in effect under this system all fish caught must be submitted to the inspection of the port authorities, which as well as facilitating detection of small commercial fish dumped to make way for larger ("high grading"), would draw attention to usage of undersized mesh through excessive volume of undersized fish.

However, the main problems of implementation acceptance of initial losses etc. all depend strongly on the co-operation and maximum involvement of the industry itself, and signs of this are already appearing in Iceland and the Anglo-Scottish FPO area tonnage but two. It is therefore in the interests of the fishermen and their representatives — assuming they would like to increase average incomes by say 50% — to examine ways themselves of reducing effort, surviving the period of initial loss, and organising the distribution of the increased long-run profit in a situation where time, boats or both must be limited to avoid depleting the stock back to its current poor, overfished level. These are the people whose incentive should be strongest and who with help and backing of the management economists should be in the best position to regulate the fisheries so as to eventually access the substantially increased profit.

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Technological and Institutional Dynamics: The Role of the UK Herring Industry Board From 1945 Onwards

by

CHRIS REID

Centre for Marine Resource Economics (CEMARE), Portsmouth Polytechnic*, Portsmouth, UK

ABSTRACT

The role of institutions in the development of fishing technologies is frequently overlooked. Yet these institutions hold considerable sway over the industry and contribute greatly to the overall economic environment within which technological change occurs. The paper considers the contribution of one such institution, the UK herring Industry Board, to the shaping of technological change and the mechanisms by which it undertook its research activities.

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INTRODUCTION

Rapid technological change occurred in marine fishing between 1945 and the 1970s; diesel engines replaced steam, radio communications and navigation came to be regarded as essential tools of the fisherman and nets and ropes made from synthetic fibres ousted their cotton and hemp counterparts. This experience, common to most of the world's fisheries, and has since been recognised as the *second industrialisation of fishing* (Cushing, 1988, pp. 234-258). However, technological change does not always present itself to the fishery in a positive light; it acts as a *two edged sword,* initially raising productivity but also establishing a self-perpetuating pattern of intensifying competition that drives forward innovation.

The participation of the UK herring fishery in this process of global technological advancement was notable, not least because of its impact upon the resource base. The highly exploitative new purse seine and pelagic trawl fishing methods employed from the mid-1960s in conjunction with sophisticated shoal location devices were the undoubted cause of the depletion of the resource base. The trend of declining catch rates which established an incentive to adopt ever more effective boats and gear was finally halted with the prohibition of herring fishing in North Sea (1977) and West of Scotland (1978).

Innovation in the herring industry resulted from the diffusion of new fishing technologies and endogenous development. A common bond between the two mechanisms by which the innovations entered the fishery was provided by the Herring Industry Board, the regulatory body established to oversee the industry's management. The Board performed the evaluation, development and promotion of fishing technologies with the objective of steering the fleet towards efficiency and profitability. Originally intended for the immediate post-war restructuring of the fleet the Board continued the research and development of fishing technology through to the 1970s. As such its activities provide a unique insight into the institutional contribution to the development and diffusion of fishing technologies.

TECHNOLOGICAL DEVELOPMENT IN FISHING

Research and development is the deliberate search for, and the subsequent refinement of, new technological solutions to identified needs. The manner in which these processes are undertaken, and their subsequent success or otherwise, is conditioned by a number of factors. The identification of problems and the degree of certainty that they are resolvable lies at the core of the research process. The mobilisation of sufficient resources, the evaluation of performance and the absorbtion of change are critical tasks facing institutions seeking to provide solutions. These tasks in themselves

*Now University.

are subject to constraints of time and cost. Compatibility with past practices or intended futures further conditions the process.

Technological change involves modification to both the technology and technology practice; the *hardware* of boats, nets and ancillary gear *software* of organisational and operational skills. For example, technological change may result in an increase in vessel size but this may in turn influence what technologies will be demanded in the future. Changes to vessel size and the diversity and complexity of the gear and ancillary equipment alter the composition of the hardware element. Technological change also enforces restructuring of the way fishing is organised and performed; ownership and remuneration systems may require adjustment to accommodate equipment costs while new technology necessitates the learning of new skills and, in some cases, the unlearning of old practices. The extent to which new technology changes the process of fishing is dependent upon whether innovation is a complement too or substitute for the existing regime. An example of an innovation intended to complement the current vintage would be a new type of shoal location device. An example of a substitute would be the employment of a new type of vessel, such as the stern trawler replacing the side trawler.

A wealth of literature has emerged detailing how fishermen perform the selection of new innovations and the means by which they are tested and evaluated. This has tended to obscure the institutional contribution. The majority of the world's fisheries since 1945 have been subject to a degree of control, regulation and support. For several reasons this support has extended to the development and testing of fisheries technology. Fisheries institutions can perform the *search* for potentially useful technologies, provide support and expertise to the industry to promote its adoption and acquire information that may assist its management of the fishery and the enforcement of regulations and standards.

The development of new technology is conditioned by the environment within which it takes place. The marine environment imposes strict restrictions upon how development activities are undertaken; while limited on-shore simulations of fishing technologies are possible they cannot replicate the extreme conditions experienced during actual fishing. The development of fishing technology was achieved without extensive recourse to formal scientific modes of enquiry. Rather, development and testing under those conditions for which it was intended predominated.

Below are identified seven major mechanisms by which fisheries authorities can assist the emergence of new fishing technologies emerge and undertake their appraisal:

1. through the use of research vessels.
2. through the use of commercial fishing vessels under contract to undertake trails.
3. through co-operation with other fisheries institutions.
4. through co-operation with manufacturers of fishing boats and gear, and manufacturers of equipment with potential fishing applications.
5. through skills transfer: (a) overseas visits with industry representatives; (b) industrial placements; (c) the employment of overseas fishing expertise.
6. through the encouragement and support of fishermen's own research and development.
7. through recourse to specialist expertise outside fisheries institutions.

While in existence the Herring Industry Board employed all of these measures to facilitate the technological advancement of the industry.

DEVELOPMENT THROUGH THE USE OF RESEARCH VESSELS

Fisheries research necessitates the practical testing of new technologies under operational conditions. The use of research vessels for this purpose offers several advantages for the fishery organisation. Firstly, while designed to operate as fishing vessels they also make provision for measuring and monitoring equipment, space for which is often not available on commercial vessels. Secondly, the use of research vessels also enables the organisation to undertake research without

prejudicing fishermen against the technology, which may be possible while technologies are in an early stage of development.

Against these must be weighed the disadvantages of research vessels. Perhaps the most obvious disadvantage of acquiring and maintaining a number of research vessels are the costs incurred by the organisation. For a relatively small industry-specific body such as the Herring Industry Board these costs were considerable. Secondly, the variety of vessels is likely to be limited and consequently their findings could have little significance for a proportion of the fleet.

In the immediate post war period the Board had little option but to acquire their own boats. A large number of the herring fleet had been requisitioned by the Admiralty and many of these had been lost during service. However, this was not the major impediment to using commercial boats; those vessels not destroyed had long passed the point of obsolescence. Consequently, few boats were worth employing for research purposes while fishermen were primarily concerned with returning to their occupation.

A second factor underlying the Board's acquisition of its own research vessels was its continued determination to establish the type of vessel most suited to catching herring in good condition at the lowest cost. This objective entailed research beyond simply finding the least cost methods of performing pre-war tasks; options were available that could have had a major effect upon the industry. One such was shift from year-round prosecution of herring around the coast to the use of dual purpose vessels capable of switching over during the year between herring and demersal fishing on the same grounds.

The design of these vessels followed pre-war investigations carried out by the Board to determine hull-forms that would afford greater fuel efficiency. Following the war industry representatives were consulted to see if these boats were of an acceptable design; the new designs were considered 'too revolutionary' but the Board expressed the hope that the industry would gradually come around to the new designs.

In 1946 the Board tendered for two 65 ft. diesel powered steel hulled drifters of the new design for research purposes. Tests carried out on the new vessel types confirmed the Board's expectation that these could increase profitability by reducing the variable costs of catching herring, (Herring Industry Board, 1950, pp. 34-39). These boats were seen as embodying *best-practice,* being economical to run and performing well during fishing. As such, they represented for the Board a model of technological advancement which the Board was keen to see duplicated throughout the fleet.

The two vessels gave the Board a high degree of flexibility over the research projects which could be undertaken. Importantly, they allowed for the simultaneous evaluation of a number of technologies, such as trials to ascertain the potential of shoal locations and communications technologies in the late 1940s. Research of this type is particularly significant given that many of the more important developments in marine fishing since 1945 resulted from the interaction of several innovations in a *technological nexus,* (A classic example of a fishing process that exploited the nexus potential of developments in hydraulics, electronics and synthetic fibres was purse seining, see Whitmarsh, 1977, pp. 109-110).

The use of their own research vessels should be viewed as a response to the inability of the commercial fleet to provide a platform upon which to undertake trials of new technologies.

By the early 1950s the fleet had rebuilt and was able to fulfil that function and consequently the necessity for research vessels was not so great. The Board's research vessels were subsequently chartered to fishermen in 1951. One lessee was sufficiently impressed with the vessel he had chartered to purchase it in 1953. The remaining vessel was retained by the Board for research purposes and was later transferred to operations under the auspices of Department of Agriculture and Fisheries for Scotland. The primary role of the research vessel in the Board's research program was assumed by the commercial fishing vessel, although the research vessels of other fisheries agencies continued to provide support and specialised monitoring equipment whenever necessary.

DEVELOPMENT THROUGH THE USE OF COMMERCIAL FISHING VESSELS

The integration of commercial fishing vessels into the Board's research program began in earnest from the early 1950s, although there had been pre-war precedents. A number of factors underscoring this change in direction appear to have been significant. Firstly, the Board's programme to the early 1950s had been concerned principally with the adaptation of existing inventions, such as sonar, the Decca Navigator, the radio telephone and the diesel engine. By the early 1950s the potential of these devices was fully appreciated by herring fishermen and their knowledge regarding their use had become widespread. The Board's attention turned towards the dedicated fishing technologies then emerging from manufacturers and towards the examination of alternative methods of catching herring. The interest in fishing techniques was stimulated by the renewed concern with reducing the cost of catching herring. The fleet had prospered from the immediate post-war demand for cheap protein, but as the revival of consumerism began to gain momentum it was recognised that the industry would once again be subject to stringent competition from other foodstuffs once rationing ended.

The Board's financial position also necessitated a move towards employing commercial vessels. The provisions of the 1944 Herring Industry Act had included direct Government funding for those research activities in which the Board had engaged. As the industry moved towards financial stability it was to generate sufficient income to support the Board, through a levy on landings and the issue of licences. Commercial vessels were a cheaper means to achieve the same end.

Given the intention to carry out tests under working conditions the use of commercial vessels was not surprising, but it is necessary to recognise the advantages that derive from such an arrangement. The choice of a particular fishing method encourages learning by doing around that technique and the subsequent development of variations upon the original theme. *Learning by doing* has been responsible for much of the post-war technological progress in fishing and explains why non-formalised knowledge has been to the forefront. As Eddie, (1983, p. 44), notes,

> how to make the best of echosounders, warp tension meters and other fishing aids was discovered, not by the engineers who developed them, but by the highly-successful skippers who were the first to be persuaded to try them out.

These skippers were able to evaluate new technologies by virtue of their tacit understanding of the complexities of commercial fishing.

The potential for *learning by doing* is best realised when there is a high degree of familiarity with the technology in question. In the case of the UK herring fishery the choice of, and adherence to, particular fishing methods encouraged innovation to occur in this manner while determining the subsequent direction of technological progress. The Board's research activities from 1945 recognised as much; the stated intention being to raise the productivity of the predominant drift and ring net fishing techniques. In the opinion of the Board the potential for development had been demonstrated by the increase in productivity following the widespread adoption of new technologies, such as the echo sounder, which complemented their use. Through the increasing employment of new technology it was hoped that these fishing methods would allow a reduced fleet to meet the requirements of the processing sector.

The function of any fisheries agency is not only to develop new technologies but also to encourage their use, and this rationale underscored the Board's actions throughout the period. The involvement of commercial fishermen contribute towards this objective. One reason for this was, as pointed out by the Board's General Manager, that the Board did not "want to burst on the industry with some entirely novel idea" (Anon. 1966-67 (para. 638)), which might only serve to alienate fishermen and prejudice them against innovation. Collaboration between agency and industry champions the use of a new product/process and enables fishermen to form opinions on performance and suitability. Typically, competitive pressures force fishermen to imitate the adoption of those technologies that offer a competitive advantage to early adopters; by advertising these advantages the agency aims to accelerate this process.

DEVELOPMENT THROUGH CO-OPERATION WITH OTHER FISHERIES AGENCIES

In the UK a clear division of responsibility was established for research between the fisheries departments and the non-governmental bodies. The former were to be concerned with fundamental marine research and investigations into the efficiency and effects of catching methods. To fulfil their obligations to the industry, the latter were to carry out pilot experiments in a commercial situation. The Herring Industry Board, following this principle, stated its objective of dealing mainly with the sponsoring of research by appropriate organisations, and of the application, either commercially or experimentally, of such findings from fundamental research as seem to merit development, (Anon. 1954, p. 28).

The Board contributed to the research of other institutions but, as the smallest of the governmental and non-governmental fisheries agencies, was more often the recipient of funding and facilities to support its own projects. The assistance provided to the Board by other domestic fishing institutions took one of two forms; assistance for specific projects generally involving the loan of some particular equipment, expertise or funding, and the longer term co-operative relationship. Of these it was the latter that had the most significant impact upon the Board's activities.

Following its formation in 1952, the Board enjoyed its closest relations with the White Fish Authority, a non-governmental body formed for similar reasons and performing similar tasks. Unlike the Board, the structure of the White Fish Authority made provision for research and development. Following the opinion of the Fleck Committee on the importance of research and experimental work in marine fishing (Anon, 1960, Cmnd. 1453, Para. 32), the White Fish Authority's research activities were further extended and the Industrial Development Unit established. From the mid-1960s the Board's relationship with the White Fish Authority became ever closer as the Board began to devolve much of its research relating to the catching to the White Fish Authority. The merger of the two authorities was suggested on several occasions during the 1960s as the Board's status was reduced by the diminishing scale of herring fishing, although this did not take place until the formation of the Sea Fish Industry Authority in 1981.

The first major collaborative agreement came with the establishment of the Herring Industry Board/White Fish Authority Joint Technical Committee on the design and construction of inshore fishing vessels as a joint response to the Merchant Shipping Safety Rules of 1965. This collaboration came at the time when trawling for herring was becoming more widespread and therefore the processes of herring fishing and white fishing were converging. The degree of collaboration was heightened when in 1967 the Board announced its intention to channel specific work on the catching sector through the W.F.A.'s Industrial Development Unit, a measure strongly influenced by the increasing financial constraints upon the Board's ability to undertake such work (Inability to fund extensive research became more acute during the 1960's as the Boards income from a levy on the catch decreased as landings fell). The relationship varied according to the type of research the Industrial Development Unit was engaged in and whether it had been initiated by either the Board or the White Fish Authority, though increasing it was the latter that provided the lead.

It should also be recognised that the Board enjoyed relations with several non-fishing institutions. Among the collaborating institutions were the National Institute of Oceanography, the Ministry of Defence, the Torry Research Station and the National Physical Laboratories Ship Division. Also, in addition to the domestic fisheries institutions the Board also maintained contact with overseas agencies, although collaboration does not appear to have been extensive. Trials of Canadian and U.S. developed technologies in 1972 were indicative though that the Board was willing to go beyond the U.K. to obtain expertise. This principal was evident in the Board's relations with manufactures and overseas fishermen.

DEVELOPMENT THROUGH CO-OPERATION WITH MANUFACTURERS

A significant proportion of the technological innovations adopted by the UK herring industry in the post war period had their origins in manufacturing. Electronic shoal location, navigation and communications, hydraulic gear handling, synthetic fibre nets and ropes all originated in the manufacturing sector and were intended primarily for non-fishing uses. The transition from invention to innovation is a two-fold process; firstly, it is necessary to recognise that an invention can be usefully applied to a certain purpose and, secondly, that its use for that purpose establishes the possiblity of profits being derived from its use. Manufacturers, fishermen and fishermen's institutions all contributed to the innovatory climate that saw these innovations come into general usage; manufacturers aimed to earn profits from sale of boats and gear, fishermen sought new technology to gain an advantage over competitors while institutions such as the Herring Industry Board strived to establish a profitable and efficient industry.

Reference to the Board's Annual Reports reveals that co-operation with manufacturers was not uncommon; that co-operation was not reported more frequently was probably the outcome of the limited space available in the Board's Annual Report in which to report on the year's developments in the catching sector. Those projects in which the co-operation of the manufacturers was indicated dealt principally with new and untested technologies, where the input from manufacturers would be most effective, although it would be expected that much small scale collaboration went unreported.

Collaborative trials offered a number of advantages to the Board; not only was it able to keep pace with new developments in a field undergoing rapid technological advancement but co-sponsored trials were also less draining on Board funds as both parties generally contributed to the expenses incurred.

Although influential within the industry it was likely that the Board's practice of testing within the fleet was the prime attraction for manufacturers; the motives of manufacturers for employing commercial vessels were ostensibly the same as those of the Board. Commercial vessels provided manufacturers with a rigorous testing bed for their products that was credible among the potential customers. It has long been recognised that much of the information that promotes the diffusion of new technologies is acquired through experience of the technology in action, through word of mouth or by observing the landings made by the vessel partaking in the trials. Manufacturers recognised that a technology's satisfactory performance in commercial tests could establish for it a favourable reputation among the fleet. As in other industries during the decades following the war, manufacturers of fisheries equipment would be fully aware of the benefits to be gained from associating a particular brand of gear with success.

Collaborative research into the potential for synthetic nets and ropes between the mid-1950s to the early-1960s illustrated the productive potential of such arrangements. Although the potential applications for synthetic fibres was recognised early on, the translation of that potential into effective fishing gears was not so readily achieved. A number of problems beset the transition from cotton to synthetic fibre nets and rigging; the determination of type of twine best suited to the task, the rigging of the nets so as to be suitable for use with the existing gear and knot slippage distorting the mesh of the nets. The Board engaged in trials with a large number of manufacturers of nets, ropes and gear to resolve such problems, with the initiative for such undertakings coming from both parties.

DEVELOPMENT THROUGH SKILLS TRANSFER

While the Board utilised commercial fishermen's unique knowledge of herring fishing it was understood that this consisted almost exclusively of skills relating to drift and ring net fishing. Consequently, while herring fishermen were capable of evaluating technologies appertaining to these techniques technologies that fell outside this experience presented problems.

These problems were evident during trials of a purse seine net by a Lerwick fisherman in 1950 and 1951. In the original trials the gear was damaged owing to the inexperience of the fishermen who normally fished by the ring net method. Once repaired the Board consulted the fisherman involved to ascertain whether experience suggested possible modifications to the gear for use under the conditions found in UK waters. The results were reported in the Board's Annual Report:

> the modifications which he [the fisherman] suggested were of such a nature and extent as to change the whole character of the net and the Board concluded that the purpose could be served equally well by using an orthodox ring-net, (Anon., 1951, pp. 27-28).

The trials were discontinued and the gear returned to Norway.

Fishing techniques such as purse seining and trawling had no tradition in the UK fishery and consequently fishermen had little option but to test these techniques with the skills they already possessed. As indicated in the above example, this was not always a good match. The Board acted to augment the experience of the UK fleet by harnessing the comparative advantage of overseas fishing expertise in these techniques. The Board's position was summarised in 1966 by its general manager, who opined that "when you introduce any new method you tend to go to the best expert there is, wherever he may be in the world, and pick his brains". (Anon. 1966-67 (Para 654)).

The key problem highlighted by the above case of the purse seine trials was the lack of experience with fishing methods alien to the UK industry but frequently employed by other herring fishing nations. Unlike many of the new product innovations, such as the echo sounder or hydraulically operated deck gear, these were not readily assimilated within the existing pattern of herring fishing and necessitated learning new skills. The most effective means of acquiring these skills was to see the gear in action and participate in the fishing process. The Board organised a number of visits overseas to familiarise UK fishermen with alternative fishing gears, such as the purse seine, pair-trawl and mid-water trawl. The engagement of overseas fishermen to direct trials of new fishing technologies aboard vessels of the UK fleet gave fishermen the opportunity to learn new skills on familiar grounds. The need for re-skilling was underlined by a member of the North Scottish Light Trawl Fishermen's Association who, commenting upon the experience gained from such activities by fellow members, recognised that "we have a lot to learn; we have been learning a lot". (Anon. 1966-67, Para 702, p. 155).

While overseas fishermen contributed greatly to the technological advancement of the UK industry domestic fishermen generated their own innovation, a fact not lost on the Herring Industry Board.

DEVELOPMENT THROUGH THE DEVELOPMENT OF INDUSTRY PROJECTS

The Board's activities aimed to direct herring fishermen's innovative tendencies towards that technology which it regarded as best suited to the fishery, the overall intention being to disseminate opinion regarding the availability, cost and performance of the technology on offer. The participation of herring fishermen in Board trials and the open circulation of results were the principle mechanisms by which it hoped to achieve this objective. This, however, was not a one way dialogue and the Board was open to suggestions from the industry.

Several types of activity undertaken by herring fishermen could have suggested areas for development in collaboration with the Board. Fishermen commonly engaged in incremental adjustments to their vessels and gear with the intention of establishing a competitive advantage over their fishing rivals. Over time a continuing process of incremental innovation could lead to significant revisions of the vessel, gear or mode of operation, which could then be brought to the Board's attention for evaluation and development. The co-operation with a drifter owner in the early 1960s to develop a drift net hauler of his own design was the outcome of the owners own experiments in this field, with the owner seeking Board assistance to develop the device beyond the prototype stage. Fishermen also approached the Board to investigate particular needs or examine developments they themselves had come across from other sources, such as the request from a commercial operator to investigate the potential of lugger fishing in the mid-1950s.

Industry projects were undertaken where viable, although Board activities were limited in this field. Not surprisingly most herring fishermen sought to retain any advantage they may have gained through their own initiative and, as intimated earlier, their principal contribution to developing the Board's thinking on technology and the fleet came through their contribution to Board projects.

DEVELOPMENT THROUGH RECOURSE TO SPECIALIST EXPERTISE OUTSIDE FISHERIES INSTITUTIONS

The construction of dual purpose vessels capable of fishing for herring or demersal species had been encouraged by the Board but were still not in general use by the early 1960s. Board attention was drawn to the increasing necessity for herring boats to supplement their earnings from fishing other species as concern over the sustainability of then current levels of fishing effort intensified.

The main impediment to their adoption for many herring fishermen was the difference in crewing requirements between the two techniques; seining required two fewer crew members than the more labour intensive drifting but the occupational structure of herring fishing did not readily lend itself to flexible-crewing arrangements. (Crewing difficulties present in gear-switching between drifting and seining arose because crew members often relative shareholders. Drift net fishing was usually organised on a relatively egalitarian 'team' basis, and continuity in crew composition contributed to the overall efficiency of the fishing operation.) Harmonising the crewing requirements of the two techniques would remove the major obstacles to gear switching.

A firm of industrial consultants was engaged in 1961 to ascertain the most effective means of reducing the manpower requirements of drifting to those of seining. This was to be achieved via the mechanisation of the on board labour process following a detailed study. Subsequently three developments were outlined as especially worthy of development; a hydraulically driven net roller with powered hauling sheaves and mechanised net shaker and bush rope coiler. The successful development of these products would, it was foreseen, conclude in sufficient ergonomic savings to allow for the reduction of the drift net crew. These findings were readily accepted by the Board which understood that, at that particular time, the fleet was not ready to adopt new fishing techniques and therefore gains in productivity would have to be achieved within the drift net regime.

From the early to mid 1960s the consultants recommendations formed a research agenda which the Board actively pursued. Considerable effort was expended upon developing and testing devices that would achieve labour savings in drift net fishing, which extended to developing nets and rigging suitable for use with the new devices. The Board's efforts were superseded mid-decade by developments in pelagic trawling and purse seining, both of which offered higher catch rates and reduced crewing requirements. The mechanisation the drift net labour process was discontinued but similar development work continued for the ring net fleet.

CONCLUSION

The principle of direct government intervention in the UK marine fishing industry dates from the early 1930s, with the creation of the Herring Industry Board indicating the future direction of government intervention. The degree of government intervention increased steadily after the war; by the early 1960s it was held that the industry was incapable of surviving without assistance (Anon. 1960). It was under these protective conditions that the rapid technological advance of the UK fishing industry took place, there being an active will to see the diffusion of *best practice* fishing technologies.

The development and evaluation of new fishing technologies formed a central part of the Board's overall strategy to modernise the herring fishery from the earliest times. This represented a clear change of direction in U.K. government attitudes towards the development of marine fishing, which had previously expressed the view that the size and technical composition of fishing capacity should be determined by market forces. This perspective was abandoned following the recommendations of the Elliott Committee that provision be made for undertaking research. That research could contribute to increasing the productivity of fishing vessels was reiterated by the Report of the Fleck Committee, which acknowledged that "the Herring Industry Board meets with little criticism on this count" (Report of the Commission of Inquiry into the Fishing Industry).

During the period 1945-1960 the Board was primarily concerned with raising the operating efficiency of the established methods of herring fishing, using drift and ring nets. This entailed finding superior equipment to that currently in use which could be *bolted on* to current practice. Such activities could be undertaken by trial and error at sea to ascertain whether Product A (for example, synthetic fibre nets), were superior/inferior to product B (cotton nets). Such trials required little more than the provision of a boat and the equipment in question and, consequently, we find that the majority of the Board's research activities during the period consisted of trials using either their own boat or those of contracted fishermen while co-operating with manufacturers to ensure access to the latest developments.

The Board held that the herring market of the early 1960s was able to absorb a greater quantity of fish than was forthcoming from the domestic fleet. Two factors appear to have persuaded the Board that this problem necessitated a technological solution. The Board was influenced by the historical

precedent of the 1930s, which illustrated the problems that could arise for the fleet if the market contracted. While a larger fleet would produce the desired increase in catching capacity, it may also be vulnerable to a downturn in the market. Secondly, while considering its response to this situation the Board was aware of the large landings then being made by European fishermen using new fishing techniques on grounds also fished by UK fishermen. This demonstrated to the Board that a technological solution to the problem of undersupply was possible if they followed the European example. The Board had experimented using new fishing gears from the beginning of its research activities, but upon the basis of trial and error rather than the systemic investigation necessary for a radical departure from common practice.

The manner in which such research was undertaken was primarily dictated by the operational resources available to the Board for such purposes. Unlike the White Fish Authority, the Board had insufficient funds to operate its own research department and, consequently, was forced to seeks collaborative mechanisms by which it could sponsor development activities. This favoured research projects orientated towards the evaluation of technological developments from other sources and their modification for herring fishing under the conditions faced in UK waters.

Throughout its attempts to promote the diffusion of new technology amongst the UK fleet the Board pursued the goals of raising awareness of innovations among fishermen and removing obstacles to their successful adoption. The practice of undertaking research activities at sea alongside the commercial fleet had the effect of inducing a *demonstration effect* (That such 'demonstration effects' are present in marine fishing is clear. While the competitive pressures of fishing under open access necessitates the adoption of new technology, the diffusion of new technologies is an imitative process). As a result, the effectiveness of new technologies under operational conditions could be seen by fishermen, thus raising the legitimacy of the Board's subsequent recommendations.

The research activities of the Board represented part of an overall strategy to promote the productivity and efficiency of the herring fleet. In addition to providing leadership the Board also gave direct financial support for investment in new boats and gear. The increasing sophistication of fishing technology necessitated ever higher levels of investment and it is probable that the pace of advancement would not have been so rapid in the absence of grant and loan assistance from the Board.

One rationale for delegating research in the catching sector to a public authority is that they are not subject to the same financial constraints that inhibit individual fishermen from innovating freely. Somewhat ironically, the Board found itself increasingly constrained from the mid 1960s by a reduced income from the levy charged to herring fishermen and from a shift in governmental attitudes, signified by the Fleck Committee report, that favoured self sufficiency as a goal for the fishing industry. From the early 1960s it began to formalise aspects of its research activities as illustrated through its growing relationship with the White Fish Authority and its use of outside expertise.

An examination of the Board's research activities from the early 1960s indicate that its contribution to the technological advance in the industry was diminishing. By the mid 1960s it had become apparent that the Board's influence over technological choice was slight, as demonstrated by the rapid diffusion of pelagic trawl and purse seine fishing techniques. While the Board's continued existence from this point may have been necessitated by a number of related factors, principally related to marketing, its role of as innovator had been superseded by an industry that had become self-sufficient in this capacity.

Given the past history of the industry is not unnatural that the Board remained preoccupied by fleet modernisation and technological advance. However, the Board was unable to adapt its objectives once the industry was ready to assume this role. With hindsight, it is possible to argue that the Board should have directed its energies towards the management of the fishery and the establishment of an effective agenda for conservation. Notably, while the Board variously advocated a number of management and conservatory positions it continued to patronise the familiar, but increasingly obsolete, stance on technological progress.

Overall, the Board can be credited with some success in promoting a more rapid pace of technical innovation amongst U.K. herring fishermen. While the Board was not responsible for the development of the new pelagic trawl and purse seine techniques or for their adoption by UK fishermen, it is probable that without the Board identifying and overcoming early technical problems the transition would have been less smooth. This policy, however, was not without its critics from within the industry some fishermen expressing the opinion that the new fishing techniques promoted by the Board were destructive of the natural resource. The Board itself held reservations about the possible results of new fishing methods upon the resource base (Whitmarsh, Reid, Gulvin and Dunn "Natural Resource Exploitation and the role of New Technology: The UK Herring Industry, 1960-1980"), but continued its promotion of technological change as necessary for the long term improvement in the industry's fortunes up until the closure of the fishery.

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Address
CEMARE, Department of Economics, University of Portsmouth, Locksway Road, Milton, Southsea, Portsmouth, Hampshire, UK. PO4 8JF.

Telephone
Portsmouth (0705) 827681, Ext. 4108

Optimal Annual Changes in Harvests from Multicohort Fish Stocks: The Case of Western Mackerel

by

JOHN O.S. KENNEDY

School of Economics and Commerce, La Trobe University, Melbourne, Australia

ABSTRACT

An optimising model is developed to determine the sequence of total allowable catches of western mackerel which would result in the maximum present value of the stream of annual rents. It is found that the optimal steady state fishing mortality would be one half to one third of recent levels. For the base formulation of the model the optimal plan calls for periodic fishing, with a moratorium on fishing for the first two years, and for a very substantial catch in the third year. The sensitivity of pulse fishing as an optimal strategy is tested with respect to number of solution iterations, asymmetric charges for increasing fleet capacity, quadratic adjustment costs, harvesting stock effects, the rate of discount, and the price elasticity of demand for mackerel.

Key Words:

Dynamic programming
Optimal control
Western mackerel
Total allowable catch
Pulse fishing

INTRODUCTION

A system of setting total allowable catches (TACs) for a wide range of fish stocks for Member States of the European Community (EC) was institutionalised in 1983 under the Common Fisheries Policy (CFP). Judging from the TACs set since then, it is clear that they would have to be set much lower to allow a substantial future flow of economic rents from most European fisheries. Many stocks are under pressure, or overexploited. Some have been so heavily exploited in the past that for a time harvesting has had virtually to cease. Such has been the case with North Sea herring, is currently the case with North Sea mackerel, and may in future be the case with western mackerel.

It is of concern that nowhere in the system of determining TACs, from the International Council for the Exploration of the Sea (ICES) working groups to the EC Fisheries Commission, via the Advisory Committee for Fisheries Management and the Scientific and Technical Committee for Fisheries, does there appear to be any attempt to estimate the economic surpluses which could be derived from alternative settings of TACs through time. Although efficiency considerations must be weighed against equity considerations, some estimates of potential surpluses are essential. Gulland (1987) argues that in order to improve the efficiency of management of North Sea fisheries the long-run strategic benefits and beneficiaries of TAC settings must be identified, with a shift in emphasis away from short-run tactical considerations in setting TACs.

At present the advice on TACs to the EC Fisheries Commission is based on a range of biological criteria. Laevastu and Favorite (1988, p.193) state: "The setting of TAC has, in most cases, the objective of protecting the reproduction capacity of stocks so that these will not fall below levels where recruitment might be severely limited by an inadequate size of spawning stocks". A much more fruitful approach would be for the Fisheries Commission to arrange for biologists and economists to combine their expertise and produce estimates of economic surpluses for alternative TAC regimes. Otherwise the suspicion must exist that TACs are set little lower than open access catches, implying a very high weighting on short-term employment in the industry.

Whilst there are good public choice reasons for the lack of progress in implementing more economically efficient TACs, another reason may be that the optimal harvest profiles for multicohort fisheries tend to be highly irregular, particularly for the initial years. This phenomenon is referred to as periodic fishing, or pulse fishing in the extreme case where zero fishing continually alternates with high levels of fishing. It has been noted and rationalised by Hannesson (1975), Clark (1976) and Horwood and Whittle (1986). It is associated with imperfectly selective harvesting technologies, under which juvenile fish are caught indiscriminately with adult fish even although the adult fish contribute most to rents. Hannesson (1975) found that in simulations for North Atlantic cod, present values obtained for fishing mortality held constant over time were not far below the maximum present value from pulse fishing.

The aim of this paper is to describe a dynamic optimisation procedure for a multicohort fishery problem, which can also provide as a by-product relatively smooth harvesting profiles with modest reductions in net present value from the optimal value. As well, alternative fisheries problems are formulated which take account of some of the costs associated with year to year changes in harvests. The western mackerel fishery is taken as an example application.

THE MODEL

The model is used to find the annual sequence of rates of fishing mortality across all years which results in the maximum present value of annual social rents, given initial stock numbers in each cohort. Equations for the annual catch and updating of stock in each cohort taking account of recruitment and natural and fishing mortality are based on the Beverton and Holt (1957) model.

There are n age classes. The stock numbers in the i-th cohort in year t are denoted $x_{i,t}$. Using u_i to denote the proportion of stock in the i-th age class which is sexually mature, and w_i^s the average weight of fish in the i-th cohort at spawning time, the spawning stock biomass is:

$$B_t = \sum_{i=1}^{n} u_i w_i^s x_{i,t} \tag{1}$$

Recruitment is given by the Beverton and Holt (1957) stock-recruitment equation:

$$x_{1,t+1} = \gamma B_t/(1+B_t/\theta) \tag{2a}$$

or is set as a constant:

$$x_{1,t+1} = \bar{x}_1 \tag{2b}$$

Instantaneous rates of fishing and natural mortality are assumed to hold constant throughout the year. The stock updating equations are:

$$x_{i+1,t+1} = x_{i,t}\exp(-q_i f_t - m) \quad (i=1,\dots,n-2) \tag{3}$$

$$x_{n,t+1} = (x_{n-1,t} + x_{n,t})\exp(-q_{n-1} f_t - m) \tag{4}$$

where f_t, the control variable, is the instantaneous rate of fishing mortality, q_i is the proportion of fishing mortality effective on fish in the i-th age class (selectivity) and m is the instantaneous rate of natural mortality. As shown in (4), provision is made for fish surviving beyond age n. They are treated as having the same average weight of aged-n fish.

Using matrix notation the stock dynamics can be summarised as:

$$\underline{x}_{t+1} = \underline{s}_{t+1} + D_t \underline{x}_t \tag{5}$$

where $\underline{x}_t$ is the (nx1) vector of stock numbers at the start of year t, $\underline{s}_{t+1}$ is a (nx1) null vector except for $x_{1,t+1}$ (from equation 2) in the first element. Elements of the (nxn) matrix D_t are zero except for:

$$d_{i,i-1,t} = \exp(-q_i f_t - m) \quad (i=2,\dots,n) \tag{6}$$

$$d_{n,n,t} = \exp(-q_n f_t - m) \tag{7}$$

Thus non-zero elements of D_t are a function of f_t, and non-zero elements of $\underline{s}_{t+1}$ are a function of $\underline{x}_t$. In subsequent analysis of optimality conditions it is necessary to refer to the (nxn) matrix $\delta\underline{x}_{t+1}/\delta\underline{x}_t$. This is written:

$$\delta\underline{x}_{t+1}/\delta\underline{x}_t = \begin{cases} G_t + D_t & \text{(recruitment function 2a)} \\ D_t & \text{(constant recruitment 2b)} \end{cases} \tag{8}$$

where Gt is a (nxn) null matrix except for:

$$g_{1,i,t} = u_i w_i^s \gamma/(1+B_t/\theta)^2 \quad (i=1,\dots,n) \tag{9}$$

The social net return in year t is the social value of the harvest h_t, measured by willingness to pay, less the cost of effort in obtaining the harvest. Willingness to pay is given by the area under the demand-for-fish schedule, which for a linear demand schedule is:

$$\mathrm{WTP}\{h_t\} = ah_t + bh_t^2/2 \tag{10}$$

where a and b are the parameters of the inverse demand schedule.

If the simple Schaefer (1957) harvesting function applies, the instantaneous harvest of i-th age class is:

$$h_i = \psi x_i e \tag{11}$$

where e is instantaneous fishing effort and ψ is a constant termed the catchability coefficient. The instantaneous rate of fishing mortality for the i-th age class is:

$$h_i/x_i = f_i = \psi e \tag{12}$$

Allowing for fixed selectivity in harvesting from age classes:

$$f_i = q_i f = q_i \psi e \tag{13}$$

where f is potential instantaneous fishing mortality for all age categories. It follows that if effort is maintained at constant level throughout year t at e_t, the potential instantaneous fishing mortality also remains constant at $f_t = \psi e_t$. Moreover, if total harvesting cost is proportional to e_t, it is also proportional to f_t, and can therefore be written as $c_1 f_t$ where c_1 is the cost per unit of potential fishing mortality.

The harvest from the i-th age class over year t is obtained by integrating all instantaneous harvests over the year, and equals:

$$h_{i,t} = w_i^c x_{it}(1 - \exp(-q_i f_t - m)) q_i f_t/(q_i f_t + m) \tag{14}$$

where w_i^c is the average catch weight of fish in the i-th cohort. Equation (14) is an approximation to the extent that w_i^c depends on past and current rates of fishing mortality.

Total harvest for the year is:

$$h_t = \sum_{i=1}^{n} h_{i,t} \tag{15}$$

The net social return in year t is thus:

$$y\{\underline{x}_t,f_t\} = ah_t + bh_t^2/2 - c_1 f_t \tag{16}$$

where $\underline{x}_t$ denotes the stock vector.

As there is no obvious terminal date for the cessation of fishing the planning period is treated as endless. It seems reasonable to suppose the stock dynamics equations remain the same across all years. Demand and harvesting functions are more likely to change over the planning period, but they are also assumed to remain the same for lack of other information. These assumptions make the problem stationary, which means that an optimal policy relating f_t to $\underline{x}_t$ for year t is also optimal for any other year. The problem considered here is how to set $f_1, f_2, \ldots$ so as to maximise the present value of social net returns, and is stated as:

$$\text{maximise} \quad \sum_{t=1}^{\infty}(1+r)^{1-t}y\{\underline{x}_t,f_t\} \tag{17}$$

with respect to $f_1, f_2, \ldots$

subject to $f_t \geqslant 0$ (all t)

$\underline{x}_1$ given

and $\underline{x}_{t+1} = \underline{s}_{t+1} + D_t\underline{x}_t$ (all t)

where r is the annual rate of discount. This is a discrete-time optimal control problem.

THE SOLUTION PROCEDURE

Optimising methods which have been used to solve discrete-time multicohort fishery problems include non-linear programming (e.g., Horwood, 1987), mixed integer programming (e.g., Glen, 1990) and dynamic programming (e.g., Kennedy and Watkins, 1986). Other methods have been based on approximations to the optimality conditions of dynamic programming. For example, Horwood and Whittle (1986a and b) show how a linear control rule can be determined for multicohort fishery problems which is locally optimal around the optimal steady-state stocks for each cohort and the optimal steady-state fishing mortality. Kennedy (1989a) allows for the shadow prices of stocks in each cohort to change across years, but solves for the near-optimal fishing mortality in each year with the approximating constraint that there is no change in the shadow prices from the beginning to the end of that year.

The solution approach of Kennedy (1989a) is extended in two ways. Allowance is made for the price of fish to be a linear function of catch, and for a Beverton and Holt recruitment function. Secondly, an iterative procedure is used to successively improve on harvesting profiles until the optimality conditions hold to some required degree of accuracy. An important result from the western mackerel application is that the potential increase in net present value from the iteration procedure is marginal, and comes at the expense of a change from a smooth harvesting profile to highly irregular profiles.

The optimality conditions for the solution to (17) can be derived from first principles very directly using the recursive functional equation of dynamic programming (see Kennedy 1986, Ch.1). Let $V\{\underline{x}_t\}$ denote the present value of social net returns from setting $f_t, f_{t+1}, \ldots$ optimally each year for evermore. Note that because of discounting $V\{\underline{x}_t\}$ is finite, and that because the problem is stationary and the planning period boundless, the value of the same stock vector $\underline{x}_t$ in any other year would also be the same. Thus it should be the case that:

$$V\{\underline{x}_t\} = \max_{f_t}[y\{\underline{x}_t,f_t\} + \alpha V\{\underline{x}_{t+1}\}] \quad (t\text{-}1,2,\ldots) \tag{18}$$

where $\alpha = (1+r)^{-1}$ and $\underline{x}_{t+1}$ is related to $\underline{x}_t$ and f_t by the stock dynamics equation (5). The equation splits the value of the stock between the current net return from deciding on f_t and the discounted

value of the stock remaining for the start of year t+1, provided $f_{t+1}, f_{t+2}, \ldots$ are set optimally. Assuming that the expression in square brackets is a concave function of f_t, the complementary slackness conditions for the optimal setting of f_t in (18) are:

$$\delta y/\delta f_t + \alpha(\delta \underline{x}_{t+1}/\delta f_t)\underline{\lambda}_{t+1} \begin{cases} = 0 \text{ for } f_t^* > 0 \\ < 0 \text{ for } f_t^* = 0 \end{cases} \tag{19}$$

where $\underline{\lambda}_{t+1}$ is the (nx1) vector $\delta V/\delta \underline{x}_{t+1}$ evaluated at $\underline{x}_{t+1}$.

The meaning of $\delta V/\delta x_{i,t+1} \equiv \lambda_{i,t+1}$ is immediate. It is the present value of an additional unit of stock in the i-th age class, given the stock level is $x_{i,t+1}$, and is the Lagrange multiplier or costate variable of other methods. If the vector $\underline{\lambda}_{t+1}$ were known for all t, it would be possible to solve (19) for optimal $f_t = f_t^*$ for all t. By rewriting (18) as:

$$V\{\underline{x}_t\} = y\{\underline{x}_t,f_t^*\} + \alpha V\{\underline{x}_{t+1}\} \quad (t=1,2,\ldots) \tag{20}$$

differentiating with respect to $\underline{x}_t$, and using (8), the relationship between $\underline{\lambda}_t$ and $\underline{\lambda}_{t+1}$ can be written:

$$\underline{\lambda}_t = \delta y/\delta \underline{x}_t + \alpha(\acute{G}_t + \acute{D}_t)\underline{\lambda}_{t+1} \quad (t=1,2,\ldots) \tag{21}$$

By the envelope theorem, because (19) holds, terms for change in f_t^* do not appear in (21).

However (19) is not of immediate help unless $\underline{\lambda}_{t+1}$ is known. The method adopted for finding a solution is to first find a f_t path and corresponding x_t path (t=1,2,...) for which (19) and (21) hold approximately, and then to improve on the paths by an iterative process until (19) and (21) hold to some required degree of accuracy.

The initial trial path is obtained by first supposing that $\underline{\lambda}_2$ is not too much different from $\underline{\lambda}_1$. Setting $\underline{\lambda}_2 = \underline{\lambda}_1$ in (21), and given the initial stock vector $\underline{x}_1$, an estimate of optimal $\underline{\lambda}_2$ is:

$$\hat{\underline{\lambda}}_2 = [I - \alpha(\acute{G}_1 + \acute{D}_1)]^{-1}\,\delta y/\delta \underline{x}_1 \tag{22}$$

where I is an (nxn) identity matrix. Substituting $\hat{\underline{\lambda}}_2$ for optimal $\underline{\lambda}_2$ in (19) for t=1 and solving for $f_1 = \hat{f}_1$ gives an estimate of f_1^*. The stock updating equation (5) enables $\underline{x}_2$ to be found for $\underline{x}_1$ and f_1. By similar argument, $\hat{\lambda}_3$ may be found, and hence the entire trial decision path $\hat{f}_t$, and associated $\hat{\underline{x}}_t$ and $\hat{\underline{\lambda}}_t$ paths.

If there is some t = T for which $\hat{f}_T = \hat{f}_{T+1} = \ldots$ and $\hat{\underline{x}}_T = \hat{\underline{x}}_{T+1} \ldots$ then $\hat{\underline{\lambda}}_T = \hat{\underline{\lambda}}_{T+1} = \ldots$. In other words, at time T a steady state is attained $\hat{f}_T \equiv f^*$, $\underline{x}_T \equiv \underline{x}^*$ and $\hat{\underline{\lambda}}_T \equiv \underline{\lambda}^*$. The path from $\underline{x}^*$ onwards is optimal because (19) and (21) are satisfied.

An iterative procedure starts to improve on the f and $\underline{x}$ paths. A backward sweep is conducted from t=T to t=1, in which (21) is used to find iteration-1 estimates $\underline{\lambda}_T^1,\ldots,\underline{\lambda}_1^1$ of $\underline{\lambda}_T^*,\ldots,\underline{\lambda}_1^*$ for points on the f and $\hat{\underline{x}}$ paths. A forward sweep is conducted from t=1 onwards, in which (19) and (5) are used to find f_t^1 and $\underline{x}_t^1$. Successive iterations of backward and forward sweeps are conducted until there is no significant change in paths between iterations, and (19) and (21) hold to the required degree of accuracy.

Model Data for Western Mackerel[1]

Background

The history, biology, technology and management of the mackerel fishery are described by Lockwood (1988). The management of mackerel to 1984 has been reviewed by Whitmarsh and Young (1985). The Sea Fish Industry Authority (1989) analyses the marketing prospects for mackerel. The western mackerel stock is regarded as distinct from the North Sea mackerel stock, with a spawning ground south-west of England and the Irish Republic. Adults follow an annual migration path starting in June from the spawning ground north around the coast of Britain to the feeding grounds off the coast of Norway where they winter. They make their return to the spawning ground in January and February.

The stock continues to be regarded as overexploited. Lockwood and Shepherd (1984, p.179) warned that the western mackerel stock was declining rapidly due to catches exceeding the TAG. The spawning stock biomass has declined recently from a 1983-85 average of 2,231 kilotonnes to a 1986-88 average of 1,768 kilotonnes (International Council for the Exploration of the Sea (ICES), 1989, p.46). The 1986-89 average estimated fishing mortality was 0.26, compared to an estimated sustainable value of 0.15 (ICES, 1990, p.21). It is of interest to investigate how these compare with economically efficient values of fishing mortality through time.

Biological Data
Most of the biological data required for the stock dynamics equation (5) and the instantaneous harvest equation (11) are obtained from the 1988 report prepared by the Mackerel Working Group of ICES (1988, Table 5.4). Age-specific parameters are shown in Table 1. Natural mortality is set at 0.15 for all age classes. The Mackerel Working Group does not provide a recruitment function. One function used was the Beverton and Holt equation (2a) employed by Horwood (1987) and Horwood and Whittle (1986b):

$$x_{1,t+1} = 2.02B_t/(1 + B_t/2160) \text{ million}$$

where B_t is spawning stock biomass in kilotonnes. The function was based on data available to the end of 1982, but a plot superimposed on a scatter diagram presented by the ICES Mackerel Working Group showing recruitment at age 0 against spawning stock biomass for the years 1972 to 1985 (ICES, 1988, Figure 5.1) suggested a reasonable fit. Alternatively, given random environmental factors may be more important in determining recruitment than spawning stock biomass, the following setting (2b) is also used as an alternative:

$$x_{1,t+1} = 3{,}030 \text{ million} \qquad (\forall\, t)$$

based on year 0 numbers (ICES, 1988).

TABLE 1

Age-specific Biological Parameters[a]

Age (years) i	Stock numbers at 1.1.88 (millions) n_i	Weight in catch (kg) w_i^c	Weight at spawning (kg) w_i^s	Proportion mature u_i	Fishing mortality pattern[b] q_i
0	3,030	0.049	0.000	0.00	0.00
1	2,630	0.176	0.070	0.08	0.04
2	2,250	0.222	0.139	0.60	0.52
3	807	0.318	0.233	0.90	0.74
4	2,630	0.399	0.268	0.97	1.00
5	154	0.478	0.363	0.97	1.00
6	232	0.513	0.371	0.99	1.00
7	701	0.492	0.392	1.00	1.00
8	439	0.496	0.402	1.00	1.00
9	246	0.577	0.459	1.00	1.00
10	84	0.635	0.483	1.00	1.00
11+	303	0.696	0.507	1.00	1.00

[a] Source: ICES (1988, Table 5.4).
[b] Normalised so that 1.00 corresponds to fishing mortality f = 0.27.

Economic Data
The countries reporting the three highest catches of mackerel in 1987 from both western and North Sea stocks are (in kilotonnes): Scotland (200), Norway (130) and Ireland (96) (ICES, 1988, and Department of Agriculture and Fisheries for Scotland, 1988a). Whilst the total of reported catches from both stocks is 581 kilotonnes, the estimate of the total actual catch is 628 kilotonnes, split 615 and 13 kilotonnes between western and North Sea stocks respectively (ICES, 1988). Most of the mackerel catch is exported to Eastern Europe in a trans-shipment process known as klondyking (Wood, Roberts and Oxley, 1986).

Because the Scottish fleet catches the largest component of the mackerel harvest, price and cost data for Scottish landings are taken to apply to the total catch. A more disaggregated model might be desirable, but this would require more data and a more complex model. There are no published cost and earnings data for Irish vessels catching mackerel, which are mainly mid-water trawlers. The Scottish catch is taken primarily by Scottish purse seiners for which cost and earnings data are available. Purse seiners are also used for the Norwegian catch.

The average price of mackerel obtained by the Scottish fleet in any year is taken to be the reported value of the Scottish catch in that year divided by the reported tonnage. On this basis the average price for 1987 was £113 per tonne for a total catch estimated by ICES of 615 kilotonnes. For the years 1983-1987 the real price of mackerel remained relatively constant, as did total estimated catch. Catch showed little trend over the same years, with a mean of 614 kilotonnes and coefficient of variation of 5 per cent. This historical record is not very helpful for estimating the price elasticity of demand for mackerel, though some estimate is important for use in an optimising model in which catches quite different from those historically observed may be considered. The elasticity appears to be high. The Marine Resources Assessment Group (1986) estimated price functions for mackerel using monthly Scottish data. Kennedy (1989b) used these functions to estimate a short-run elasticity for total estimated catch per month of about −10, allowing for the fact that Scottish landings are about one third of total landings. The demand for total estimated catch per year would likely be more elastic. In the model linear demand schedules are used which pass through the average 1987 price of £113 per tonne and the 1987 total estimated catch of 615 kilotonnes, with an elasticity of demand of minus infinity for the base run, and −5 for sensitivity analysis.

The coefficient for harvesting cost per unit of fishing mortality was estimated as follows. The Scottish purse seiners caught mackerel and herring in the ratio of about 2 to 1 by weight in 1987. Cost and earnings information collected for a sample of the purse seiners by the Sea Fish Industry Authority in 1987 was used to estimate the average cost of catching a tonne of mackerel or herring. It was assumed that the costs of catching a tonne of each fish were equal. The average cost per tonne was multiplied by the estimated total tonnage of mackerel caught in 1987, and divided by the ICES estimate of fishing mortality for 1987 (0.27) to give a rough estimate of cost per unit of fishing mortality of £211 million.

MODEL RESULTS

Base Parameter Settings
The optimal catch and spawning stock biomass sequence over 20 years for the base parameter settings and recruitment equation (2a) are shown in Figure 1. It was obtained after 40 iterations of the solution algorithm. For the first ten years periodic fishing is practised. Harvesting is suspended for the first two years, allowing stocks to increase. Heavy harvesting is pursued in year 3, catching about 645 kilotonnes, compared with an estimated 1987 catch of 615 kilotonnes. Catch falls to zero in year 6. After year 9, harvests are more stable, never exceeding 300 kilotonnes, and reaching a steady-state harvest of 269 kilotonnes by year 33. Though the spawning stock biomass in year 20 is about the same as that in year 2, numbers of fish are more evenly spread across age classes.

Fishing mortalities required for these harvests are shown by the dot-filled bars in Figure 4. Peak mortality is 0.19 in year 3, compared with an estimated 1987 level of 0.27. Steady-state fishing mortality is 0.087 by year 25. The present value of net returns across infinite years is £135m, the steady-state annual net return being £12m. This contrasts with a present value calculated to be £46m if fishing mortality were to continue each year at 0.27, until the annual surplus is driven negative in year 5.

Figure 1

Optimal catch and stock for standard run

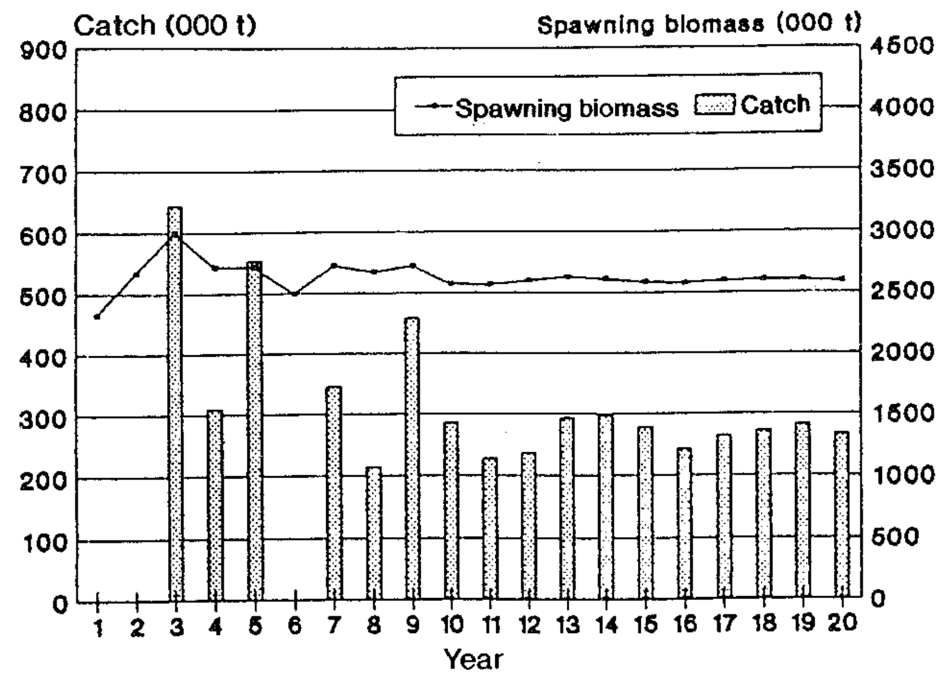


Figure 2

Optimal catch and stock for constant recruitment

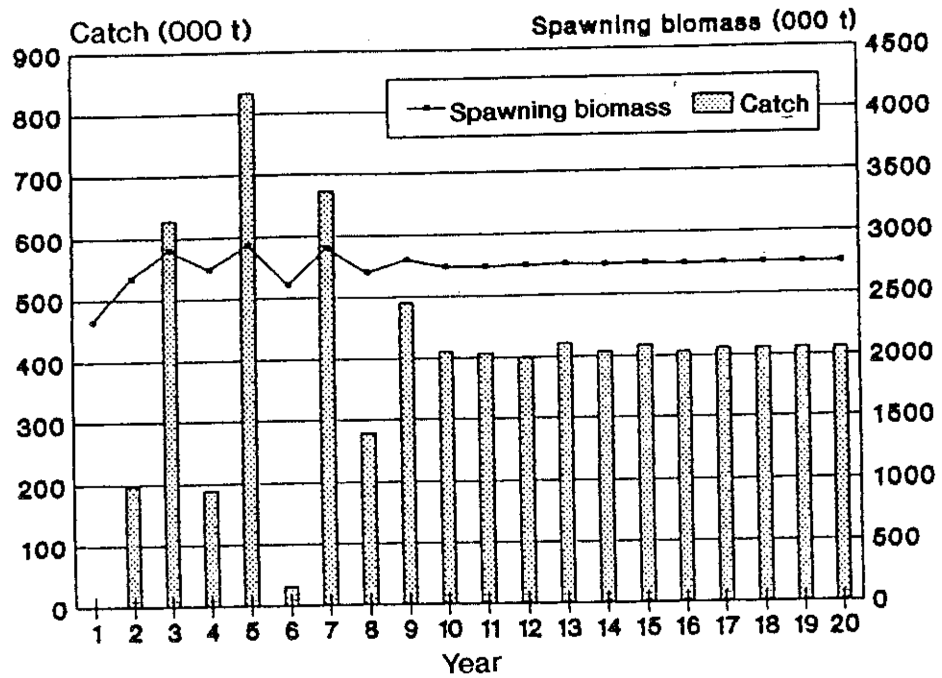
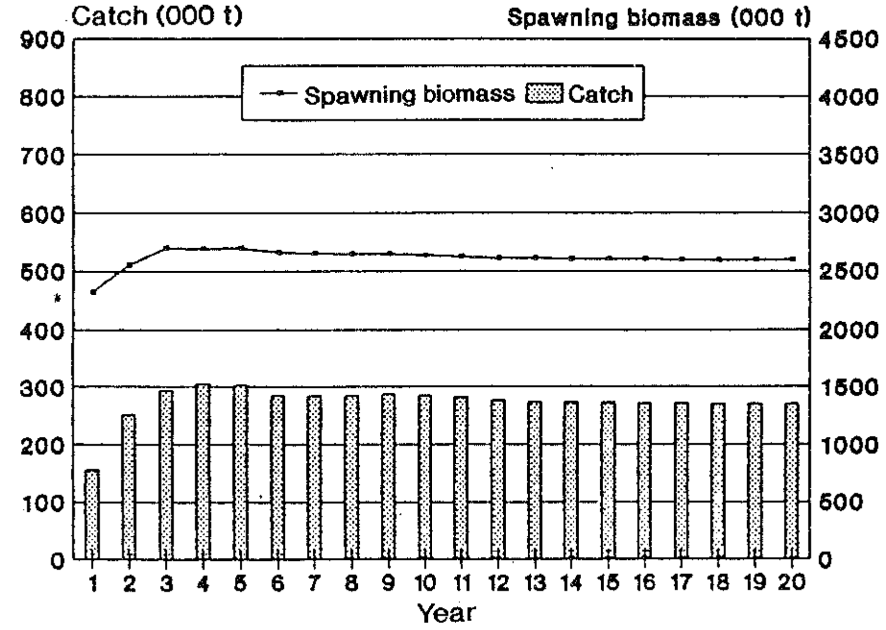


Figure 3

Optimal catch and stock for first iteration



The harvesting profile obtained for recruitment fixed at 3,030 million per year shows higher harvests on average (Figure 2), but still considerable year-to-year variation in harvest over the first ten years. The steady-state fishing mortality is 0.129, which is reached at year 20. The present value of net returns is £195 million.

The general conclusion from these runs is that the efficient long-run fishing effort is less than one half of the 1987 level, and the efficient long-run catch is less than two thirds of the 1987 level. However, catch levels would be quite irregular over the first ten years, prompting two questions. One is whether it is possible to find very nearly the same present values with a more regular harvest profile over the first ten years. With the solution procedure employed, the first-iteration solution always shows a relatively smooth harvest profile. This is because the harvest for each year is determined using the approximating constraint that the optimal marginal value of the fish stocks in each cohort is the same in the following year as in the current year. The first-iteration harvest profile is shown in Figure 3 for the Beverton-Holt recruitment function. The long-run steady-state harvests and stocks are the same, but fishing is not periodic. The reduction in present value is only 1.3 per cent.

The second question which arises is whether there are any costs associated with year-to-year variation in catch levels which are being ignored. Some of these costs and the sensitivity of the stability of the catch profile to particular parameters are considered in the following sections. The solutions presented are those obtained after 40 iterations.

Capacity and direct harvesting costs

The treatment of costs in the base run is appropriate if all costs are directly related to fishing effort and hence fishing mortality. However, in practice the harvesting capacity of the fleet targeting western mackerel may be subject to the problem of asset fixity. Net returns associated with changes in fleet capacity may be asymmetric. There will be investment costs in adding to capacity, but if harvesting is below capacity it may not be possible to obtain a corresponding return from the excess capacity. For example, it would not be possible to redeploy vessels and gear in harvesting herring if TACs for herring were sufficiently stringent. The opportunity cost of excess vessel capacity is then zero, and the relevant costs of harvesting for decision-making consist of direct or variable costs only. In such cases the investment decision is referred to as irreversible, and the capital installed as non-malleable, because there are no exit opportunities for capital. The problem of optimal irreversible investment in fleet capacity has been dealt with analytically by Clark *et al.* (1979) for common-pool fisheries models.

Figure 4

Optimal fishing mortality for direct and capacity costs

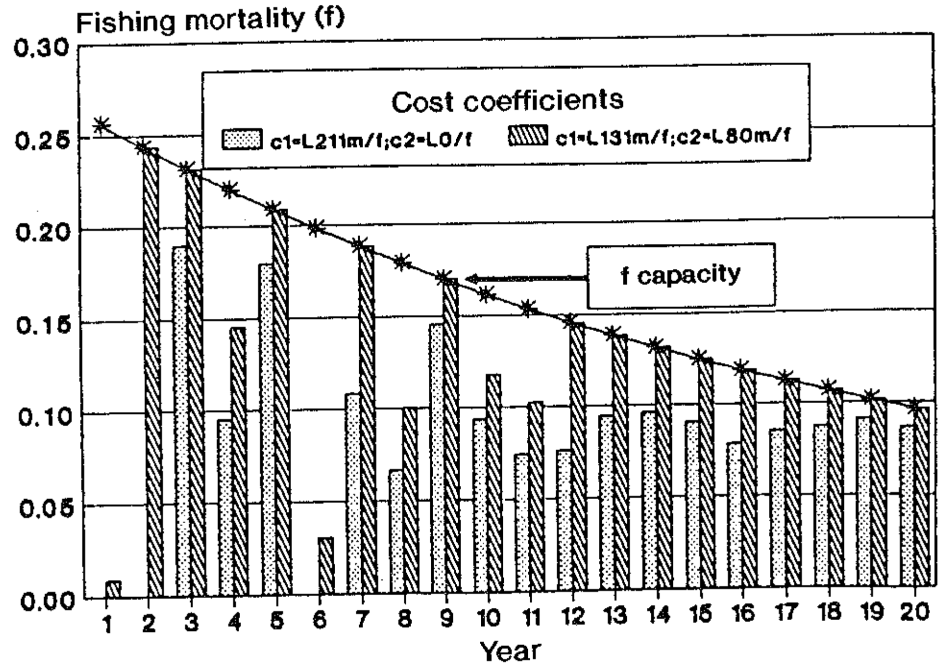
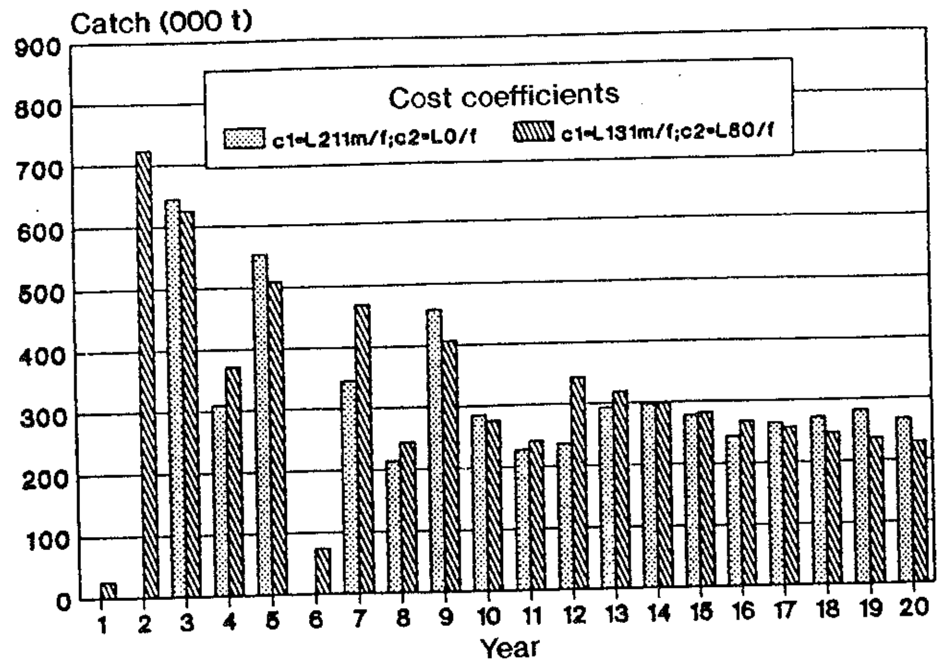


Figure 5

Optimal catch for direct and capacity costs



Irreversible investment in fleet capacity is allowed for in the model by charging for any additional capacity rented in at the beginning of each year, and checking that in the solution capacity rented in is non-decreasing from year to year. Non-decreasing renting in of capacity indicates that reversal of prior investment would not be socially profitable. It is likely to be optimal for stocks which are initially overexploited. The same approach was followed by Kennedy (1989a) in an application to the southern bluefin tuna fishery.

Although the investment decision is irreversible, fleet capacity decreases through time in the absence of investment through physical depreciation at the rate δ. Thus if fleet capacity measured in terms of potential for fishing mortality at the beginning of the year before year 1 of the plan is denoted by f^c_0, fleet capacity at the beginning of year t of the plan is:

$$f^c_t = f^c_0 (1-\delta)^t \tag{23}$$

Any capacity rented-in to cover a requirement above f^c_t is charged for at a rate of c_2 per unit of fishing mortality. The recursive DP functional equation becomes:

$$V\{\underline{x}_t\} = \max_{f_t}[y\{\underline{x}_t, f_t\} - c_2 k_t + \alpha V\{\underline{x}_{t+1}\}] \tag{24}$$

$$\text{where } k_t \begin{cases} = 0 & \text{if } f_t \leq f^c_t \\ = f_t - f^c_t & \text{if } f_t > f^c_t \end{cases}$$

Writing

$$z_t \equiv \delta y/\delta f_t + \alpha(\delta \underline{x}_{t+1}/\delta f_t)\acute{\lambda}_t \tag{25}$$

conditions for optimal $f_t = f^*_t$ are:

$$z_t = c_2 \text{ if } f^*_t > f^c_t$$

$$0 < z_t < c_2 \text{ if } f^*_t = f^c_t$$

$$z_t = 0 \text{ if } 0 < f^*_t < f^c_t$$

$$z_t < 0 \text{ if } f^*_t = 0$$

These conditions are used in the model to find f^*_t. The rate of physical depreciation was set at 5 per cent per annum, a rough estimate based on the finding from Scottish fishing fleet data (Department of Agriculture and Fisheries for Scotland 1988b) that the weighted mean age of Scottish purse seiners is 12 years. The per unit cost of fishing mortality of £211m was split between £131m for running and labour costs (c_1) and £80m for vessel and depreciation costs at 5 per cent per annum (c_2), based on SFIA 1987 cost and earnings sample data.

Optimal fishing mortalities over 20 years for direct cost coefficient c_1 = £131m and capacity expansion cost coefficient c_2 = £80m are shown in Figure 4. They are compared with optimal fishing mortalities for the base run with c_1 = £211m and c_2 = £0. Corresponding optimal catches are shown in Figure 5. With allowance for zero opportunity cost of excess vessel capacity but positive capacity expansion costs, there is minimal harvesting in year 1 but substantial harvesting in year 2. Over the first 20 years investment in new vessel capacity is not socially profitable. Fishing mortality exceeds that in the base run for the first 20 years. Fishing mortality continues to follow depreciated fishing mortality capacity to a low of 0.058 in year 30. In all subsequent years additional capacity is rented in, and by year 50 stocks and fishing mortality are the same as for the standard run.

ADJUSTMENT COSTS

There may be reasons to constrain or penalise year-to-year changes in fishing effort or fishing mortality. Examples of adjustment costs which may be incurred with periodic fishing include loss of current returns from labour and boats if they are idle because there are no alternative employment opportunities, and reduced future returns when fishing recovers if markets and processing capacity have been lost. Another important cost is that of ensuring the planned effort reduction is actually carried out. As has been pointed out by Anderson (1987) and Sutinen and Andersen (1985), fisheries management should take account of not only the economic surplus generated by a management regime, but also the costs of monitoring and enforcement under the regime. The costs of monitoring and enforcement are likely to increase more than proportionately to a required reduction in fishing effort.

Whilst it is unlikely that adjustment costs are symmetric for positive and negative changes in fishing effort, there are costs associated with increasing fishing effort, such as high short-run marginal costs of increasing fishing capacity.

To allow for adjustment costs a quadratic term was included in the annual net return function. The recursive DP functional equation becomes:

$$V\{\underline{x}_t, f_{t-1}\} = \max_{f_t}[y\{\underline{x}_t, f_t\} - c_3(f_t - f_{t-1})^2 + \alpha V\{\underline{x}_{t+1}, f_t\}] \quad (26)$$

where c_3 is the adjustment cost coefficient. Shepherd (1980) advocated a quadratic adjustment cost as part of "cautious optimisation", in an attempt to reflect more realistically the aim of policy. Horwood (1987) constrains year-to-year changes in mortality and Horwood (1989) introduces a quadratic adjustment cost in optimising models for North Sea herring.

The value of the c_3 adjustment coefficient is difficult to estimate empirically, and no attempt was made to do so in this application. By way of illustration, Figure 6 shows the results obtained for c_3 = £500m per unit change in fishing mortality squared. Compared to the pulse fishing strategy for the base run the catch profile is smooth. The greatest between-year change in fishing mortality is from 0.27 in year 0 to 0.17 in year 1. The adjustment cost for year 1 is thus £50m, which compares with net return for year 1 before charging adjustment costs of £60m. However, by year 2 the adjustment cost is less than 10 per cent of net return.

Figure 6

Optimal catch for adjustment costs

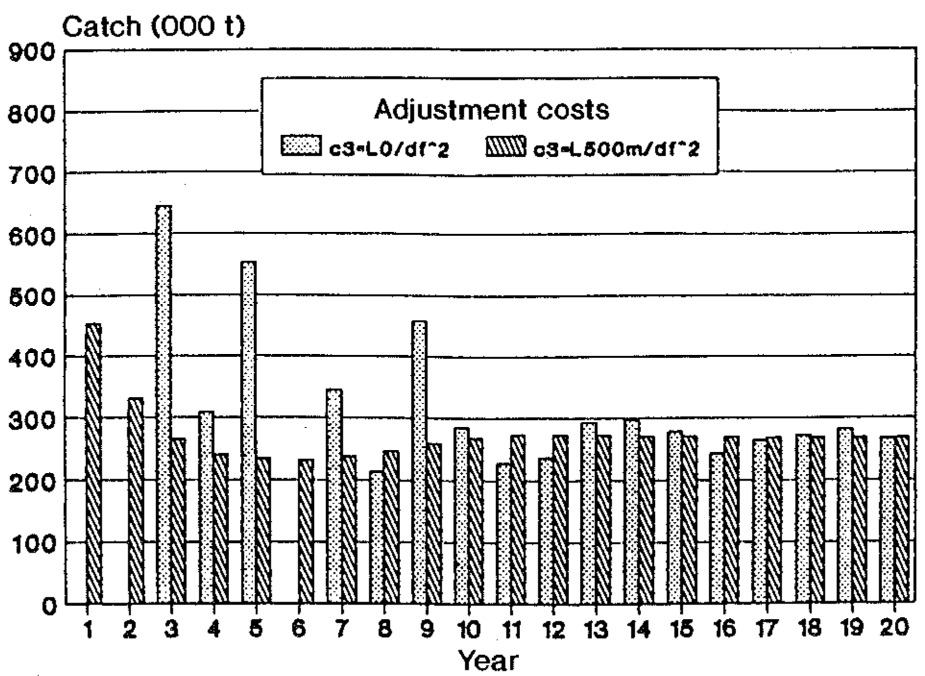
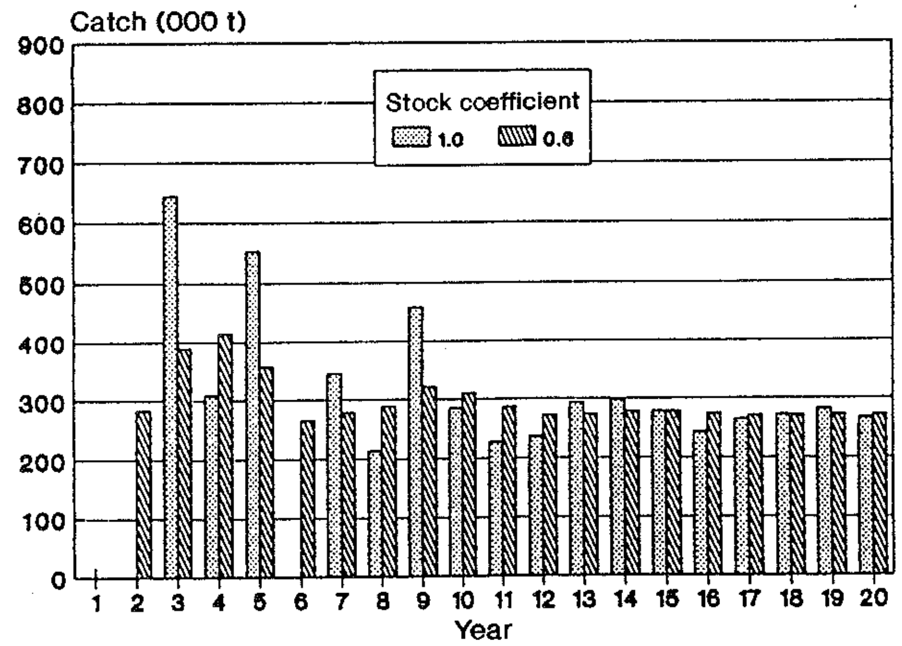


Figure 7

Optimal catch for stock coefficients



Stock coefficient in the harvesting function
Cooke and Beddington (1984) present various reasons why the relationship between expected catch per unit effort and stock abundance may be concave rather than linear. This follows if, for example, total effort is the sum of search and catch effort, or the catchability coefficient is variable.

Clark (1985) has pointed out that whilst the Schaefer harvesting function (11) is plausible for a fish stock uniformly distributed in the sea, it is not so plausible for pelagic stock which shoal. For a pelagic stock such as mackerel a more appropriate function is:

$$h_i = \psi x_i^\beta e \qquad (0<\beta>1) \quad (27)$$

Bjorndal (1987) finds $\beta<1$ for production functions estimated for North Sea herring. Compared to the case for $\beta=1$, the incentive to pulse fish is reduced because the reduction in future effort cost resulting from lower future stocks is more limited.

From (27) required fishing effort is:

$$e_t = (f_t/\psi) \quad x_{i,t}^{1-\beta} \quad (28)$$

which breaks the simple proportionality between effort and fishing mortality across all age classes in the standard model. Equation (28) cannot be easily accommodated in the model, but as an approximation the following equation relating effort to total biomass is used:

$$e_t = (f_t/\psi)\left[\sum_{i=1}^{n} x_{i,t}\right]^{1-\beta} \quad (29)$$

Continuing to assume that cost of effort is directly proportional to effort, the net social return equation becomes:

$$y\{\underline{x}_t, f_t\} = ah_t + bh_t^2/2 - c_1(f_t/\psi)(\underline{x}_t\underline{1})^{1-\beta} \quad (30)$$

where $\underline{1}$ is a column vector of ones.

Results are shown in Figure 7 for a trial value of β = 0.6. Compared to the harvesting policy in the base run for which β = 1.0, the degree of periodic fishing is reduced. Though there is still no harvesting in year 1, there is significant harvesting in year 2.

Figure 8

Optimal catch for discount rates

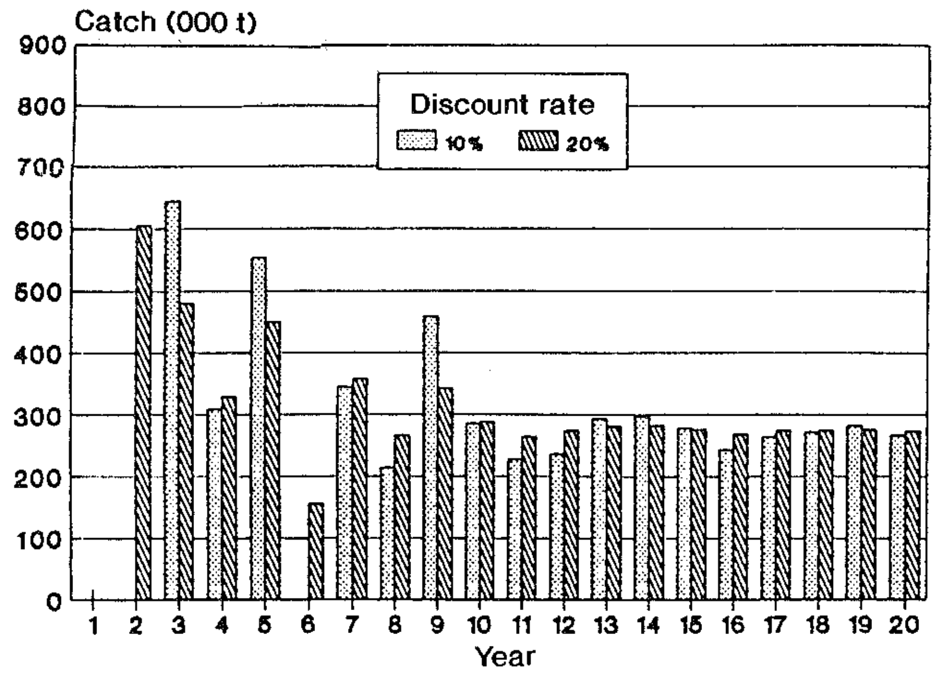
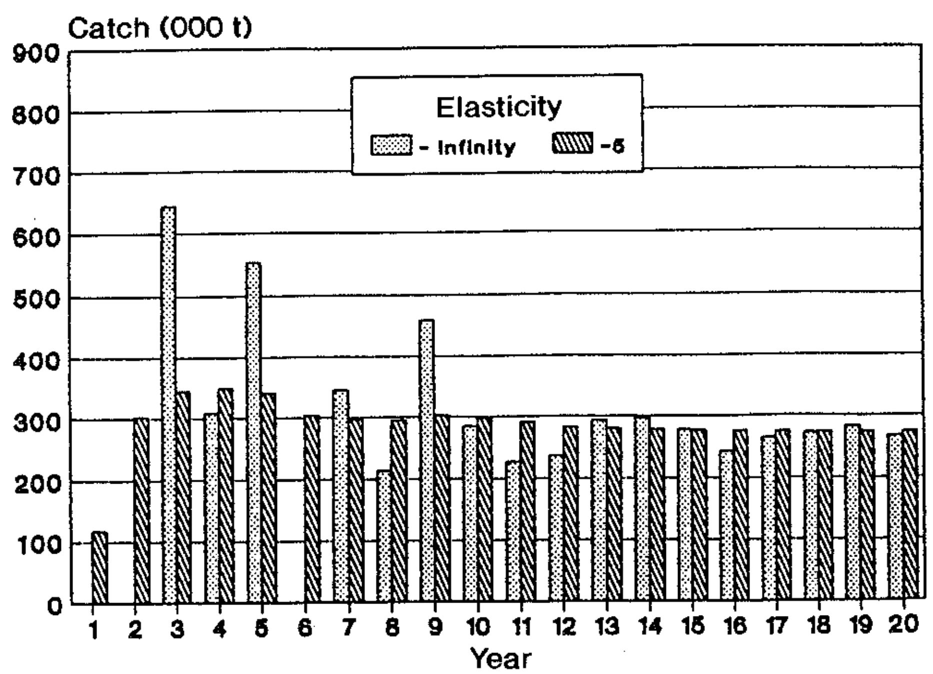


Figure 9

Optimal catch for elasticitis



The rate of discount
The incentive to pulse fish is greater the lower the rate at which annual social net returns are discounted. The planner is more willing to forego harvests in the early years so as to benefit from the lower harvesting costs associated with higher stocks in later years. Figure 8 shows the effect of increasing the rate of discount from 10 per cent for the base run to 20 per cent. Again the degree of periodic fishing is reduced, with substantial harvesting in year 2.

The price elasticity of demand
A reduction in the elasticity of demand for mackerel makes periodic fishing less attractive. A strategy of exchanging lower harvests in early years for higher harvests in later years is more costly because the marginal cost of a foregone sale when harvest is low is greater than the marginal return from an additional sale when harvest is high. In the base run of the model demand is infinitely elastic, with p = £113/tonne. Figure 9 shows results for a linear demand schedule with price elasticity of demand −5 for p = £113/tonne and h = 615 kilotonnes. Optimal catches are smoothed across the years, with some harvesting in year 1.

CONCLUSION

Model results suggest that the optimal long-run level of fishing effort directed at western mackerel would be one half to one third of current effort. An important contribution which this type of model has to offer is the estimation of the value of social returns from alternative fishing policies. This information appears to be entirely absent from the current process of determining the total allowable catch. Although reference is made to biological criteria, in the final analysis the main criteria appear to be broadly economic and social but without quantification.

However, in urging a present value criterion, there needs to be more work carried out on model formulation and data collection. Policies which recommend moratoria or drastic year-to-year changes in catch have to be treated with caution until a check is made for any costs or returns associated with changes in harvesting which may have been ignored. Checks should also be carried out to see if smoother harvesting profiles can be obtained with little sacrifice in present value. This can be done with the solution procedure described in this paper without additional computation.

In the case of the western mackerel model, the extent to which periodic fishing as an optimal strategy becomes less pronounced is demonstrated for: asymmetric charges for changes in utilised fleet capacity; quadratic adjustment costs; a reduced stock effect on harvesting; an increase in the rate of discount; and a reduction in the absolute price elasticity of demand for mackerel. Tests for each of these modifications were conducted singly, but they would most likely be reinforcing if applied in combination. Obviously the need for these modifications is a matter for empirical investigation. They should not be built into a model just to avoid periodic-fishing prescriptions.

ACKNOWLEDGEMENTS

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NOTES

1. For more detail on the data used see the full report by Kennedy (1989b), which also contains a listing of the FORTRAN program for the solution procedure.

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Individual Transferable Quotas: The Australian Experience

by

JOHN O.S. KENNEDY

School of Economics and Commerce, La Trobe University, Melbourne, Australia

AUSTRALIAN GOVERNMENT POLICY

Individual transferable quotas (ITQs) have so far been applied to only one major Australian fishery, the southern bluefin tuna (SBT) fishery. Most of this paper therefore deals with the SBT experience. However, it is Government policy to start introducing them more widely:

> The Government recognises that ITQs facilitate autonomous adjustment of fishing fleets and solve the problem of resource rent dissipation but also notes that there can be some problems with implementing them. The Government's position is that ITQs should be the preferred method for managing fisheries. Their practicality should be examined before other management controls are considered. (Commonwealth of Australia, 1989, p.24)

Geen *et al.* (1990, p.26), after referring to the problems of over-capitalisation and over-exploitation in the multispecies south east trawl fishery, state: "The need for changes to the current management system became obvious and culminated in the recent announcement that a system of ITQs on all major species is to be introduced by 1992". Already a type of ITQ system has been applied to gemfish, part of the south east trawl fishery. In 1989 the total allowable catch (TAC) of 3 kt was allocated to qualified fishermen as individual quotas which could then be leased to other quota holders (Commonwealth of Australia, 1989, p.47).

The appeal to government of ITQs lies in their promise of economic efficiency, recently stated to be a goal of fisheries management. The Government has recently laid down policy objectives which, compared to policy objectives of other administrative authorities such as those of the European Community's Common Fisheries Policy, are remarkably succinct (Commonwealth of Australia, 1989, p.vii):

(a) to ensure the conservation of fisheries resources and the environment which sustains those resources

(b) to maximise economic efficiency in the exploitation of those resources

(c) to collect an appropriate charge from individual fishermen exploiting a community resource for private gain.

THE IMPACT OF QUOTAS ON THE SOUTHERN BLUEFIN TUNA FISHERY

SBT is a long-lived species, which can survive to over 20 years of age. During their juvenile phase to the age of about 7 the fish are exploited by Australian vessels in the Australian Fishing Zone (AFZ) along the southern coasts of Australia. Japanese longliners harvest SBT in their adult phase on the high seas in the 'roaring forties' belt extending west from New Zealand to South Africa.

From 1968-69 the Japanese annual harvest fell from a peak of 60 kt to 20 kt in 1982-83. Over the same period the Australian harvest rose from about 8 kt to 20 kt. By the early 1980s the relatively high levels of the Australian catches led biologists to warn that the fishery faced recruitment failure and stock collapse. The Australian Government introduced a TAC of 21 kt in the 1983-84 season. In 1984 ITQs were introduced, which gave holders an entitlement to fish in perpetuity for a share of the TAC set by the Government at the beginning of each season. The Australian TAC is announced each year after tripartite negotiations between Australia, Japan and New Zealand which determine the global quota and country shares. Under ITQs the Australian TAC has steadily fallen, to just 5.3 kt for 1990-91. Some of the adjustments which have occurred in the Australian fishery are listed below. As Geen and Nayar (1988) note, the extent to which these were caused by the introduction of ITQs has to be judged in the context of what would have been the alternative management regime in the absence of ITQs.

(i) *Number and type of vessels*
The number of vessels has declined by about 80 per cent (Commonwealth of Australia, 1989, p.47). There has been a marked reduction in pole and line boats. Numbers of purse seiners remained at 6 from 1984 to 1987, but only 4 were operating from 1988 to 1990. Before the introduction of ITQs only the Japanese used longliners. There is now some domestic longlining off the east coast of Tasmania. Three Australian owned longliners received catch for preparation for the Japanese sashimi market in the 1989-90 season.

(ii) *Shift of effort between locations*
A major concern before the introduction of quota controls was the high level of exploitation of 1 and 2 year old fish off Western Australia. The number of very young fish caught off Western Australia has fallen to 3 per cent of the numbers caught in the early 80s. There has also been a collapse in SBT catch off New South Wales, as vessels diversified into other fisheries. Geen and Nayar (1988 p.377) argue that this would have occurred to some extent anyway given the losses being made and the decline in fish abundance before ITQs were introduced. Quota was sold by holders in Western Australia and New South Wales to tuna vessel operators in South Australia. These operators had few options for diversification.

(iii) *Change in net returns for boats remaining*
Each vessel is now taking a larger catch, so other things equal the cost per tonne of catch is less. Older, higher-value fish are targeted for sale on the Japanese sashimi market resulting in higher revenue per tonne of catch, though this is to some extent offset by higher handling costs and the higher steaming costs of accessing deeper schools of fish further out to sea. Before the introduction of ITQs most of the Australian catch was sold to Australian canneries for a relatively low price. With ITQs, vessels pass over the opportunity to fish concentrations of young fish in favour of higher-value fish.

HOW SUCCESSFUL HAVE ITQS BEEN FOR THE SBT FISHERY?

From the Government's point of view the ITQ system has worked quite successfully for the SBT fishery. Rents to the fishery have been calculated to be much higher than under alternative management regimes which have been proposed (Geen and Nayar, 1989). The catch of young fish has been reduced. The opportunity cost of catching young fish is very high because if they are left their rate of weight gain is relatively rapid and their price increases. Management costs are high for monitoring and enforcing the system, but in 1986-87 44 per cent of the management costs were being recouped from operators, and a higher proportion (up to 90 per cent) is being sought.

Key features of the SBT fishery which make ITQs an appropriate management system are:

(i) Because the species is long-lived, the TAC setting each year is not so subject to changes in setting as a result of a change in one year's recruitment.

(ii) The fish is not retailed fresh in Australia, reaching the consumer after processing either in Australian canneries or after preparation for sale on the Japanese sashimi market. This means that the number of outlets for the catch is relatively limited which facilitates checking of catch against quota entitlement. However, the increasing trans-shipment of Australian catch to Japanese carrier vessels increases monitoring costs.

(iii) Excess fishing effort from Western Australia and New South Wales was able to diversify into other less regulated fisheries, but nevertheless probably reducing rents elsewhere.

(iv) It is relatively easy to target SBT of a particular age category for catching, so the problems of highgrading (discarding low-value fish to avoid going over quota) and by-catches are not severe.

THE DOWNSIDE

From the industry's point of view there were some problems. No special adjustment assistance was provided for those exiting from the fishery. However, because quota entitlement was initially allocated on a formula basis rather than bid for, all operators gained a capitalised rent which was

realised by those leaving the fishery. The formula gave a weighting of 75 per cent to the best season's catch over the previous three seasons and 25 per cent to investment in boats and gear. Allocation was not without disputes. Bain (1985, p. 16) has stated: "It has been very difficult to allocate quotas in an equitable and acceptable manner and the Government is facing protracted and costly legal and political arguments on this issue."

There is evidence that the industry was surprised by the successive reductions in the TAC over the years. Operators who had not expected TACs to fall severely subsequently found themselves overcapitalised. There will always be uncertainty over future TAC settings due to stochastic recruitment, natural mortality and migration, and to the limited control over harvesting by overseas operators. However, the efficiency of the ITQ system could be improved if the agency responsible for setting the TACs gave an indication of the range in which future TACs were likely to be set. This has been argued before by Kennedy (1986, p.4). Even with setting TACs on a biological criterion such as avoidance of recruitment failure, it was clear that the overfishing of juvenile stocks in the late 70s and early 80s would delay recovery of the parental biomass for several years after the initial cutback in the TAC. If the declared aim of management is maximising economic rents, dynamic optimisation should be used to help in setting current TACs and in charting likely future TACs. The need for this type of information is evident in the remarks of a spokesperson for the New Zealand Fishing Industry Association:

> The third plea is for the discussion and dissemination of harvesting strategies which look some years into the future with the options for future management decisions and the updating of future TACs agreed depending on the outcomes of future research activities.
>
> It is very common for the stock assessment process to yield a single allowable catch figure, whereas the expectation or possibility of future increases or decreases is probably of much greater relevance to the commercial investor. (Rhoades, 1990, p.39)

REACTIONS TO PLANS FOR ITQS FOR OTHER FISHERIES

There are good reasons to suppose that the rapid restructuring which occurred in the SBT fishery after introduction of the ITQ system will not occur in future in a multispecies fishery such as the south east trawl if ITQs are imposed on a range of species simultaneously. This is because if fishing is already overcapitalised, it is difficult to find alternative productive uses of vessels and gear. The New Zealand experience is important to note in this regard. Across-the-board introduction of ITQs resulted in very sluggish restructuring. This is not an argument against implementing ITQ schemes simultaneously, rather it is just indicative of the difficulties involved. However, if TACs were to be set on economic rather than biological criteria, TACs would be set higher the lower the opportunity cost of excess vessel capacity.

Rhoades (1990) has also argued that there is no incentive to explore new areas for catch of a species subject to ITQs. Under any management system it is impossible for an individual finder of a new ground to appropriate all the long-run returns to the find, but under an ITQ system the finder is restricted in the extent to which he can capture short-run rents. This may be detrimental to the fishery as a whole.

The problem of ensuring that the total of targeted catch and by-catch is within quota is much more difficult in the case of a multispecies fishery. Referring to the New Zealand experience, Rhoades (1990, p.39) states: "... problems with by-catch have not been resolved despite three years of trying".

The managing director of a South Australian ship construction firm and chairman of the Great Australian Bight Trawl Industry Association has voiced concern about the social impact of ITQs. He has said in relation to the Government's newly stated management policy quoted earlier and the introduction of ITQs for the south east trawl fishery:

> The problem of the social effects of the rationalisation impact of ITQs is well known through SBT. ... the Commonwealth's policy statement puts all emphasis on economic efficiency and generating maximum economic rent from the fishery. This is clearly a change in emphasis by the Government and industry needs to assess its position. (Thomas, 1990, p.34)

CONCLUSIONS

On efficiency grounds the introduction of ITQs to the SBT fishery can be judged a success. Geen and Nayar (1988) estimate that rents generated by the ITQ system in 1986-87 (Au$6.5m) far outweigh the management costs (Au$0.6m).

The Australian Government now plans to apply ITQs to many other fisheries which is likely to reduce the scope for rapid fleet rationalisation and to lead to by-catch problems. These problems have been evident to New Zealand fisheries managers, who still judge the system a success (Clark *et al.*, 1986, p.349).

Copes (1986) has argued that the ITQ system should not be seen as a universal panacea. Different systems will suit different fisheries. He outlines 14 (non-exhaustive) possible problem areas. Lindner and Campbell (1989) have identified some sources of inefficiency which can arise with ITQs. For example, they argue that under an ITQ the optimal level of investment is lower than under sole ownership of the fishery because the reduction in the returns when catch rates are low are less than the increase in returns which can be made when catch rates are high. However, overall the Antipodean experience so far suggests that experiments with ITQ management are worth taking further.

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The Icelandic Quota Management System A Description and Evaluation

by

THORKELL HELGASON

University of Iceland, Reykjavik, Iceland*

ABSTRACT

The first attempt to manage the fish stocks around Iceland began in the 1950s by extending the nation's territorial fishing limits. The first specific regulations were put in place in 1967. Since 1984, the demersal fisheries have been managed with a combination of effort and catch quotas on an individual vessel basis. This paper describes this system and comments on some of its effects and consequences. 1991, management has been based on a new law calling for a comprehensive system, with individual transferable share quotas (ITSQ). The paper examines the rationale of this law.

HISTORICAL ACCOUNT

Fisheries management in Iceland had its foundation in a 1948 law providing for scientific protection of the fish stocks. On the basis of this law, between the fishing limits were extended 1952 and 1975 from 3 to 200 nautical miles. A law providing for the specific management of the fisheries was passed in 1976. In 1984 the introduction of a comprehensive quota system for regulating the demersal fisheries was also based on this law, although later a special law was enacted to provide for this system.

The first direct regulation of coastal fisheries started in 1967 with a quota regulation of the inshore shrimp and scallop fisheries. Here catch quotas essentially were issued to processing plants rather than to the boats.

Quota regulation was also introduced in the herring fishery. In 1965 a total quota or total allowable catch TAC was set, and in 1976 the TAC was divided into individual vessel quotas. In 1979 these vessel quotas were made transferable. Similarly, vessel quotas were introduced in the capelin fishery in 1980 and were made transferable in 1986.

The most important fisheries in Iceland are the demersal fisheries, which amount to some 80% of the total landing value, of which cod is the main species. The value of the cod landings generally amount to half the value of all fish landings in Iceland. The average cod catch in Iceland over the last six years has been some 345,000 metric tons.

Apart from technical regulations, like mesh size regulations or closing areas, the first comprehensive mechanism for regulating the demersal fishery was introduced in 1977. The main purpose was to limit the cod catch since the stock level was at an all-time low immediately after the cessation of foreign fishing in Icelandic waters in 1976. These regulations amounted basically to effort limitations. Extended holiday periods were prescribed for boats during Christmas and Easter and other holidays. In addition, a total quota was issued for the net-fishing boats. The effort of the trawlers was held in check by limiting the number of fishing days in cod fishing; cod fishing was defined as any trip where cod exceeded 15% of the landing.

Simultaneously the government tried to limit new entries into the fisheries mainly by controlling all the major sources of financial investment. In 1978 a strict regulation on importing fishing vessels was introduced, together with reducing favourable loans for the domestic construction of vessels. Nevertheless, the fleet continued to increase.

*See Appendix for present address.

In 1983 the cod catch was at an all-time low and estimation of the cod stocks showed a sharp decline, partly caused by a reduced growth rate. It was evident that the previous regulations were no longer satisfactory, apart from their negative effects on the fleets efficiency.

Under these severe circumstances, the Ministry of Fisheries, together with the major organizations in the industry, agreed to regulate the demersal fisheries in 1984 with a combination of effort limitations and individual vessel quotas. This system was extended and amended in several ways and was in use throughout 1990. A new law regulating the quota system was passed in the spring of 1990 and came into force on January 1991. Here a final step was taken towards a comprehensive system of individual transferable vessel quotas.

This paper describes the two Icelandic quota system: the one in effect from 1984 to 1990, and the new system. The paper refers to several studies on the effects of the quota system and mention's the public discussion on these management systems.

QUOTA REGULATION 1984-1990[1]

The regulation governing the demersal fisheries from 1984 to 1990 underwent several changes. However, since none of these amendments changed the basic nature of the system, we shall examine the general features of the system and comment only on the major changes.

There are three basic elements in this management system: limited entry, effort limitations and/or catch limitations.

Limited entry
As early as 1978 there was an indirect restriction on new entries. In a law 1984 providing for the licensing of all fishing vessels over 10 GRTs. In 1988 was passed in 1988 this limit was lowered to 6 GRT, but since 1991 it covers all fishing vessels. Those vessels engaged in the fisheries in 1983 obtained fishing licences. According to the 1984 law, a new vessel can be introduced into the fisheries only as a replacement for a ship that has been taken properly out of operation. The replacement vessel has to be of a similar size as its predecessor; but, there has been a tendency to upgrade the replaced vessels.

Catch quotas
The operation of each vessel was regulated under the quota system with one of two mechanisms. The basic rule was regulation with catch quotas better known as individual transferable (vessel) quotas or ITQ whereby the annual catch of each vessel of the major demersal species is limited. Otherwise, there are no limitations on the fishing operation, apart from the technical regulations on mesh sizes, area and gear restrictions and the temporary closing of spawning or juvenile grounds. On the other hand, a vessel could opt for a so-called effort quota (EQ), whereby the number of fishing days is limited. We shall first look at catch quota system.

Catch quotas were issued in 1984 to vessels taking part in the demersal fisheries in the period 1981-83. Initially there were only quotas for cod, haddock, saithe, redfish, catfish, plaice and Greenland halibut, although later some of the less important species were included in or left out of the ITQ system. The quota species generally amounted to over 95% of the total demersal landings. For the remaining demersal species, there were no limitations. The quotas issued are share quotas, they allow the vessel to land a certain share of the TAC for each of the species. To stress the fact that the quotas are share quotas, henceforth we shall use the acronym ITSQ instead of the more traditional ITQ. The quota shares were based on the average catch of each vessel in the period 1981-83. There were certain adjustments to this rule, mainly to take account of the situation where vessels were out of operation for an extended time during the reference period. Specific rules applied to a vessel which also had licences in other regulated fisheries (shellfish or capelin).

[1] The author is indebted to Kristján Skarphéinsson, Division Head, Ministry of Fisheries, for supplying much of the information in this section. See also his contribution, *Udviklingen i styringen af fiskerierne Island*, in the Proceedings of the 22nd Nordic Conference on Fisheries, Rnne, Denmark, 13-15 August, 1990.

On the basis of these quota shares, the vessels could operate under catch quota limitations, whereby the annual catch for each species is limited by the amount calculated from the vessel's share of the annual TAC. Limited exchange of quotas from one demersal species to another was allowed in some pre-described ratios, reflecting the landing prices. Furthermore, exceeding the annual quotas by 5% was also possible of course at the expense of next year's quota or keeping 10% of the current quota for the following year.

The regulation allowed for the transfer of annual catch quotas between vessels. Transfer ring from one community to another required a special permit. However, these restrictions had little or no effect. As regards the transfer of the quota shares and thereby the right to annual allocation of catch quotas the situation is different. In the period 1984-87 only transfer of the quota share from a vessel taken out of operation to a new one was allowed. As of 1988, quota shares may be transferred practically without restriction, and, transferring quota shares between vessels in operation has been allowed since 1991.

Effort quotas
Instead of catch quotas, individual vessels could under the management system used between 1984 and 1990 opt to operate under effort quota limitations.[2] The number of permitted operating days was restricted by a general rule that took into account the class and size of the vessel. Generally speaking, the effort quota reduced the normal operating time by 20%-30%.

The effort quota was combined with catch restrictions. Initially this limited only the cod catch of the effort quota vessels, but later on the trawlers operating under the effort scheme had to comply with limitations on some other species as well. These limitations were not as restrictive as those under the pure catch quota scheme. The upper limit was the maximum of either an average quota for vessels in the same class or the individual quotas raised by 20% in the beginning years and after 1988 by 10%. The effort quotas were in no sense transferable, neither the operating time nor the upper limit on catches.

The reason for including the option of an effort quota was twofold. First, there was not a consensus on the move from the earlier management system based upon effort controls, to a pure ITSQ system. The effort quota scheme can therefore be seen as a hangover of the previous management system. But, secondly, even among those favouring an ITSQ system, some voices said that those fishermen scoring low in the system due to a relatively low catch in the reference period (1981-83) should have a chance to improve their status. Therefore there was a built-in feedback from the EQ system to the ITSQ system in the sense that the catches obtained under the effort scheme could increase the individual quota shares. Thus vessels operating for some time under the EQ system would come back to the ITSQ system with a better status than before. Since this meant a lower share for the ITSQ vessels, they pressed for a change in the regulation in 1988, saying that the total shares of the EQ vessels should remain constant, thus creating harsh competition among the EQ vessels.

Small boats
The management system applied to the entire demersal fishing fleet, with one important exception: the smallest boats, defined as those under 10 GRT, were not covered. There was free entry into this fleet and there were no catch or effort limitations. In 1987 several regulations were introduced and in 1988 the vessels in the 6-10 GRT size class were included under the general licensing scheme, although to their catches were omitted by certain regulations investigates.

The next section investigates the effect of this loophole.

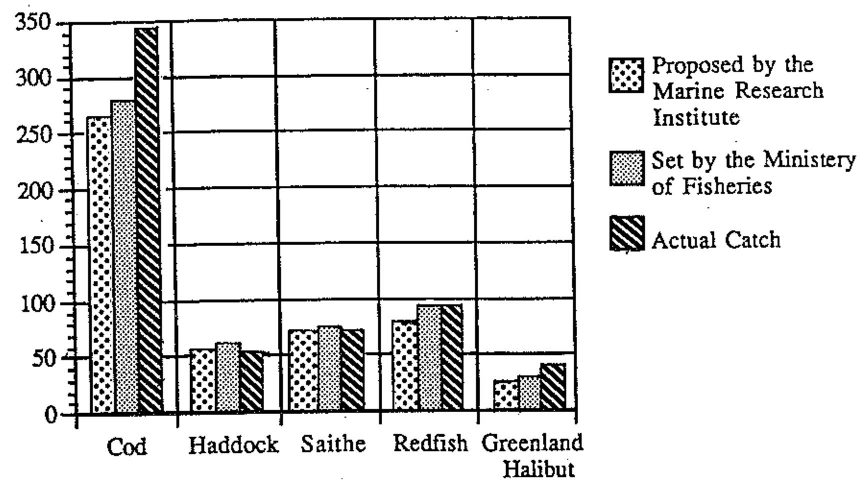
Evaluation of the quota regulation 1984-90
In this section we report on the few studies available on the impact of the Icelandic quota system.[3]

[2] In the first year, 1984, the effort quota option was actually open to only a few boats.
[3] We refer mainly to a forthcoming book by Ragnar Árnason, Dept. of Economics, University of Iceland, *The Icelandic Fishing Industry: Changing Structure and Performance*; a thesis by Jesper Raakjær Nielsen, *Fiskerireguleringen ved fartøjskvoter*, Institute for Production, Aalborg University Centre, January, 1990; the monthly *Ægir*, and the annual report, *Útvegur*, both published by the Icelandic Fisheries Society.

Total catches
The quota system was introduced in 1984 under the pressure of a major biological crisis which led to a severe reduction in the TAC for cod. Therefore, in the beginning, the main purpose of the system was to control the total catches. Figure 1 shows average numbers for this management system from 1984 to 1990. The columns show first the TAC proposed by the Marine Research Institute second, the TAC set by the Ministry, and third the actual catches for each of the species covered by the system.

Figure 1

Average proposed and actual catches, 1984-90. The vertical scale is in thousands of metric tons.



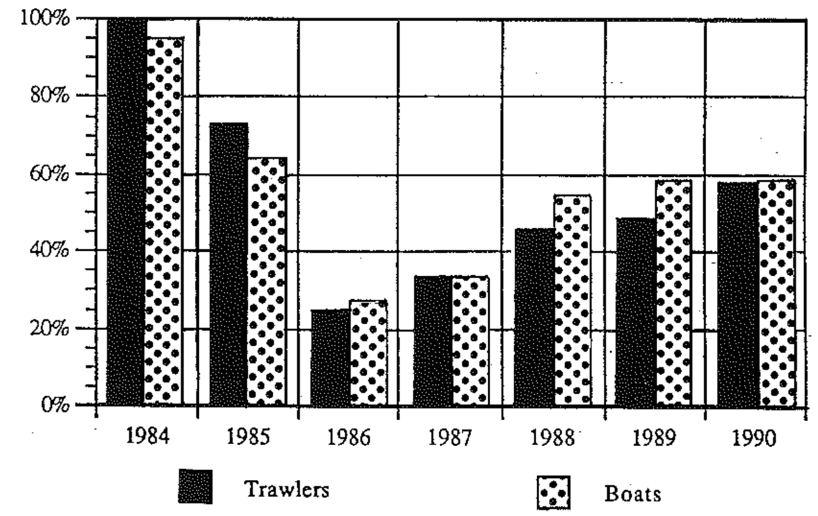
Source: Addendum to a parliamentary resolution to revise the law on management of fisheries, No. 292, submitted to the Icelandic Parliament 1990-91.

At first glance the system seems to have failed to limit the catch. The (weighted) total catches exceeded by 22% the TACs proposed by the Marine Research Institute. But the excess was only 12% if compared to the TACs set by the Ministry. Furthermore, this excess catch is easily explained. First, there is a built-in mechanism in the EQ system for vessels to exceed the set quotas. Secondly, most of the time the small boats had relatively free play. Both these effects were well known and it was predictable that the EQ effect could lead to some 10% overfishing. Therefore the total catches were basically within the limits expected by the Ministry. On the other hand there is a larger discrepancy if one looks at individual species. Here the ministerial TACs were exceeded extensively for cod and Greenland halibut, while for other species the TACs were not met. These results reflect the rather wide possibilities of changing quotas of one species into those of another.

Effort versus catch quotas
Figure 2 shows the proportion of the fleet operating under the ITSQ system, the rest being on EQ licences. In 1984 the EQ system was not a general option and few boats were eligible for it. However, although the EQ was open to all from 1985, most of the fleet opted for the ITSQ system, although the EQ system was more akin to the management they were used to. This may indicate that it was not necessary to include the EQ system as a means of adjustment from the old to the new management system. The industry started to realize the benefits of the too liberal EQ system in 1986. A study conducted before the introduction of the system indicated that, based upon economic rationale an almost equal number of vessels would opt for each of the systems. This prediction is in agreement with the average situation during the whole period.

Figure 2

Proportion of vessels (as % of total number) opting for ITSQ (in contrast to EQ) in 1984-90. Only boats concentrating their fishing on demersal species are included.

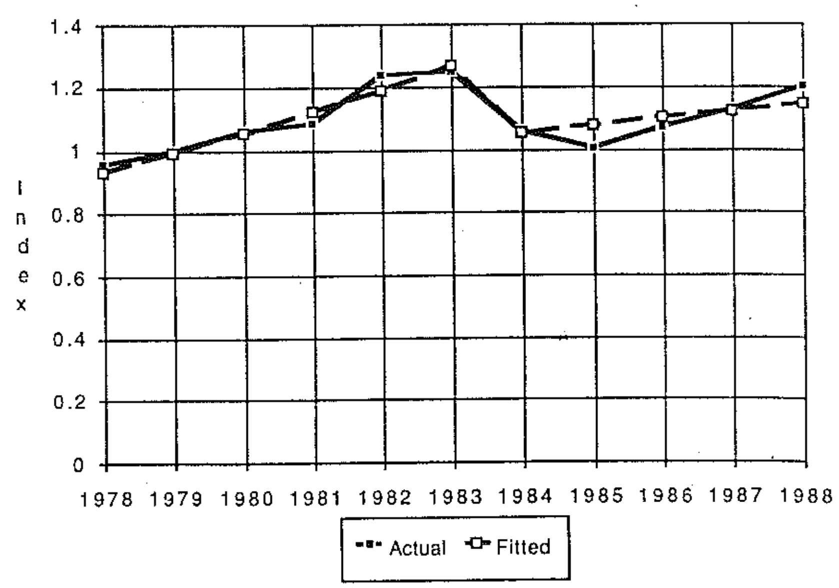


Source: Various volumes of *Útvegur*.

Increased efficiency
The second objective of the quota management system was to increase efficiency and reduce the size of the fishing fleet. Let us first consider efficiency. In the short run at least, it can be measured as the operating cost of harvesting a unit catch. Since operating cost is roughly proportional to effort, the easiest way is to look at the changes in effort or operating time. This is illustrated in Figure 3, which shows the actual fishing effort over a decade and also a curve of predicted efforts obtained by comparing distinct exponential growth curves with the observations prior to the introduction of the quota system and again after its introduction. Before 1984, effort had been increasing by 6% annually. The effort was reduced by some 21% with the introduction of the system, although after that it increased again, but only at a rate of 2% per annum.

Figure 3

Actual and fitted indices of total demersal fishing effort in the period 1978-88.



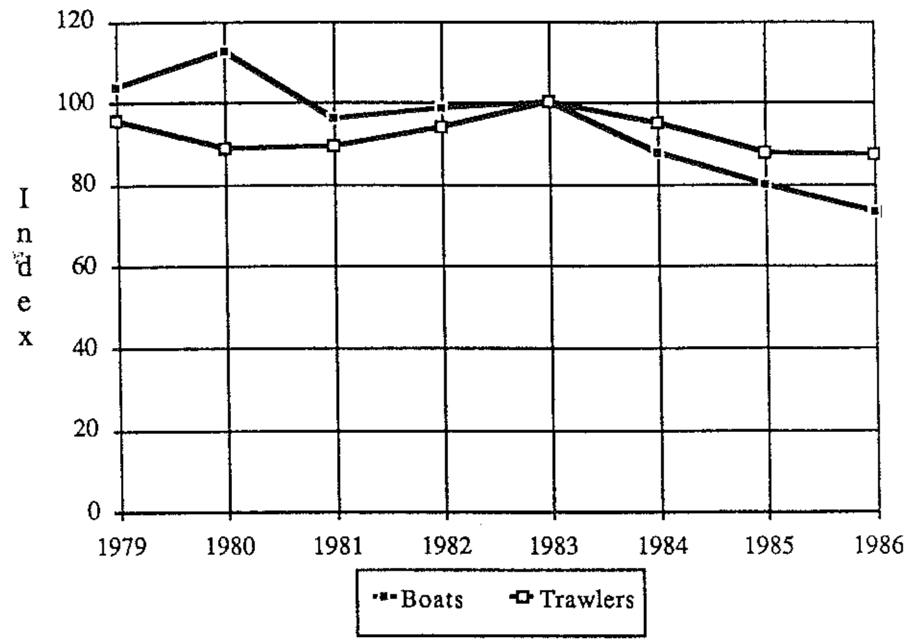
Source: Ragnar Arnason: see note 2.

Total effort is a crude measure of the cost of fishing, particularly if one is trying to isolate the effect of the management system from other factors. These other factors are principally changes in stock sizes.

Figure 4 is an attempt to calculate the cost of fishing a unit catch of cod, where the effect of changes in stock sizes has been eliminated. The stock effect is considerable since the exploitable biomass varied with a factor of three during the observation period. It is difficult to eliminate this effect; the error margin is considerable but unfortunately is not known exactly. Nevertheless, there is no reason to believe that these calculations are biased either in favour of the old mamagement system or the new . With these reservations, Figure 4 indicates that there has been a reduction in the cost of fishing, at least for the boats in the first three years of the quota system, i.e. 1984-86.

Figure 4

Changes in the cost of cod fishing per unit of catch. Base year of index 1983.



Source: Addendum (written by T. Helgason and S. Olafsson) to a bill on management of fisheries 1988-91, submitted to the Icelandic Parliament in 1987.

Transfer of quotas

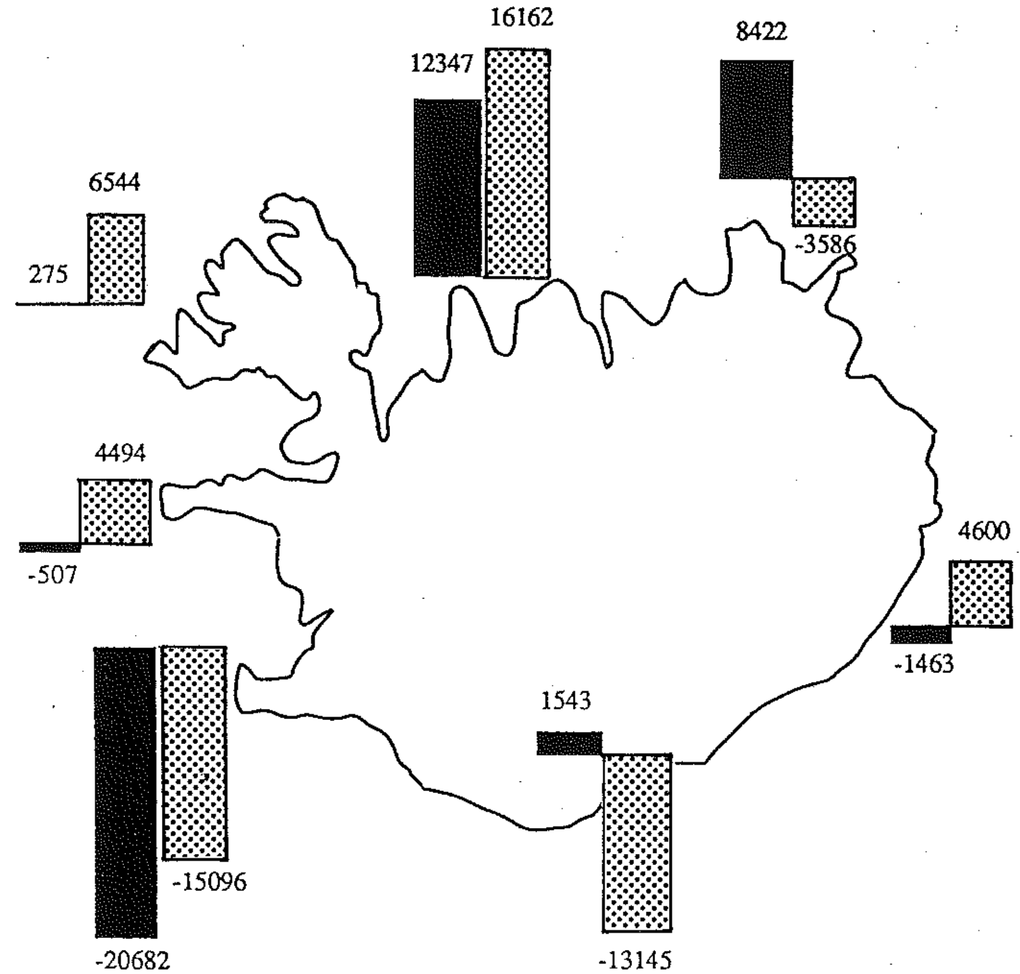
How has the reduced effort and increased efficiency been achieved? First, the reduction in effort is either directly forced by the EQ system or is allowable implied by a reduction in the catches in the ITSQ system, as compared the allowable catches under the previous system. the improved efficiency is attributable to two main causes. On the one hand, fishermen will concentrate their fishing in the periods most suitable for fishing when faced with a reduction either in operating time or the size of the allowable catches. On the other hand, it is to be expected that they will also transfer quotas from the less efficient vessels to the more efficient ones.

On average 17%[4] of the annual quotas have been transferred between vessels; varying between 10% and 20% from year to year. Most of this transfer of quotas has occurred locally between vessels owned by the same person or within the same community. However, there has also been a considerable transfer across the country.

[4] See Raakjær Nielsen, p. 47.

Figure 5

Net trading in quotas in the period 1984-89 in metric tons of cod equivalents. Left columns show trading in permanent shares (through trading in vessels) and the right ones trading in annual quotas.



Source: Egir, No. 7, 1989.

Figure 5 shows the net quota trading — both trading of annual quotas and quota shares (through trading in vessels) — between seven constituencies in Iceland.[5] It is obvious that the main trade is from the south and south-west to the north-east. This can easily be explained: the spawning stock of cod has declined considerably from its size in the reference period used for calculating the quota shares, and in the south and south-west most fishing is of this spawning stock. Thus, it is natural that the boats in this area were willing to sell some of their share and thereby reduce the economic blow of the decline of their fish stocks.

The prices paid for annual quotas varied somewhat, but were generally in the range of 20%-30% of the landing price of fish.

Quota shares change hands either indirectly through the sale of vessels or directly by transferring the shares. This latter option was in force only during the last three years of the system, i.e. since 1988. Such direct trade in quota shares nevertheless has resulted in some 50 ships being taken out of operation.

[5] Actually there are eight voting constituencies. Here the *Reykjavik* constituency is combined with the *Reykjanes* constituency, the south-west peninsula.

The going price for quotas sold this way has been c. 150% of the landing price of fish or five to seven times the going price of annual quotas. This amounts to a calculated internal rate of return of approximately 15%-20% assuming that the buyer is acquiring a permanent quota right. This interest rate is about twice the real interest rate, which reflects the doubts the quota market has about the future of the quota system.

Figure 5 shows the size of quotas transferred between the constituencies through trade in fishing vessels. The picture is basically the same as regards trade in annual quotas; a move from the south to the north.

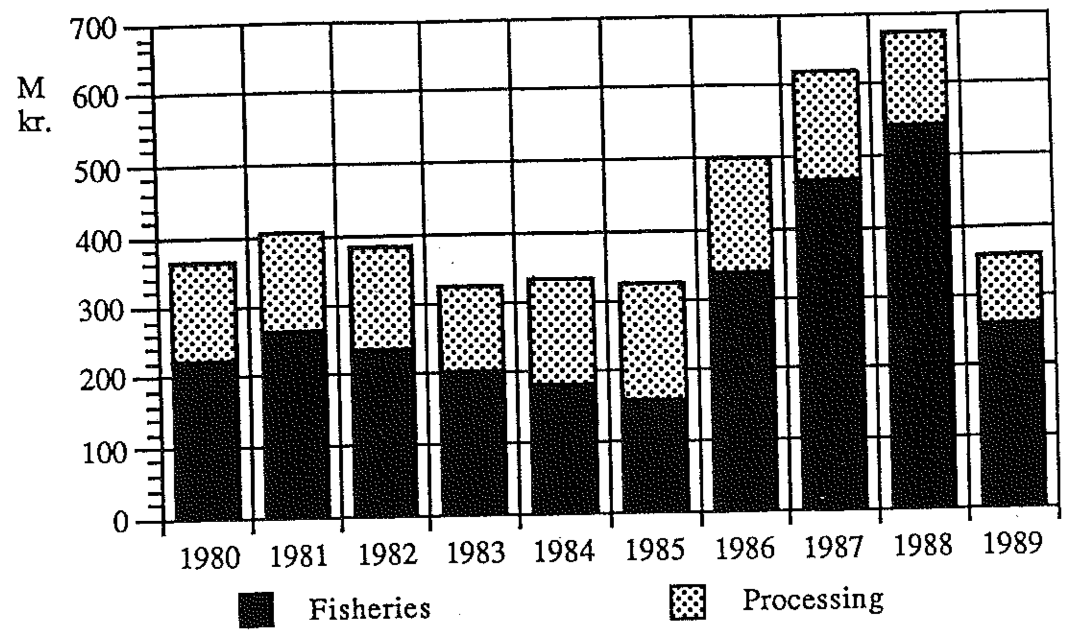
Investment

One of the major goals of a fisheries management system in Iceland and elsewhere, where the marine resources are overexploited, is to create incentives to reduce the capacity. Several studies have been conducted in the last two decades starting with a thesis by Rögnvaldur Hannesson[6] to estimate the optimal fleet size in the Icelandic demersal fishing fleet. The results vary according to assumptions, but all call for at least a 20% reduction of the current fleet and some conclude that in the long run after recovery of the stocks the fleet will be about twice too big. In the quota management system itself, the effort limitations restrict the operating time to almost two-thirds of the normal operating time.[7] And since almost half the fleet seems to be better off under these restrictions rather than the catch limitations, this indicates that the conclusion that the fleet could immediately be reduced by some 20% cannot be far off. A recent survey[8] among vessel owners — where they were asked how large a quota they could handle — also shows that the fleet has been as much as one-third under utilized.

An ITSQ system should be the ideal instrument for trimming the fleet down to the optimal size. But then at least three conditions have to be satisfied: the system must be closed, (i.e. must include all vessels and be without loopholes), the quotas and quota shares must be freely transferable, and the future of the system somehow must be secured. This last condition is satisfied if the quota shares are a permanent private property or if they constitute a long-term user right. But the guaranteed future availability of quotas on the market should also be sufficient.

Figure 6

Gross investment in fishing in the decade 1980-89 in mill. Icel. kr. (at 1980 prices).



Source: Útvegur 1989.

[6] Rögnvaldur Hannesson, *Economics of Fisheries: Some Problems in Efficiency* (Studentlitteratur, Lund, 1974).
[7] In the 1990 regulations the allowed operating time of the trawlers under EQ limitations is 230 days per year.
[8] Conducted by the Fisheries Research Institute of the University of Iceland.

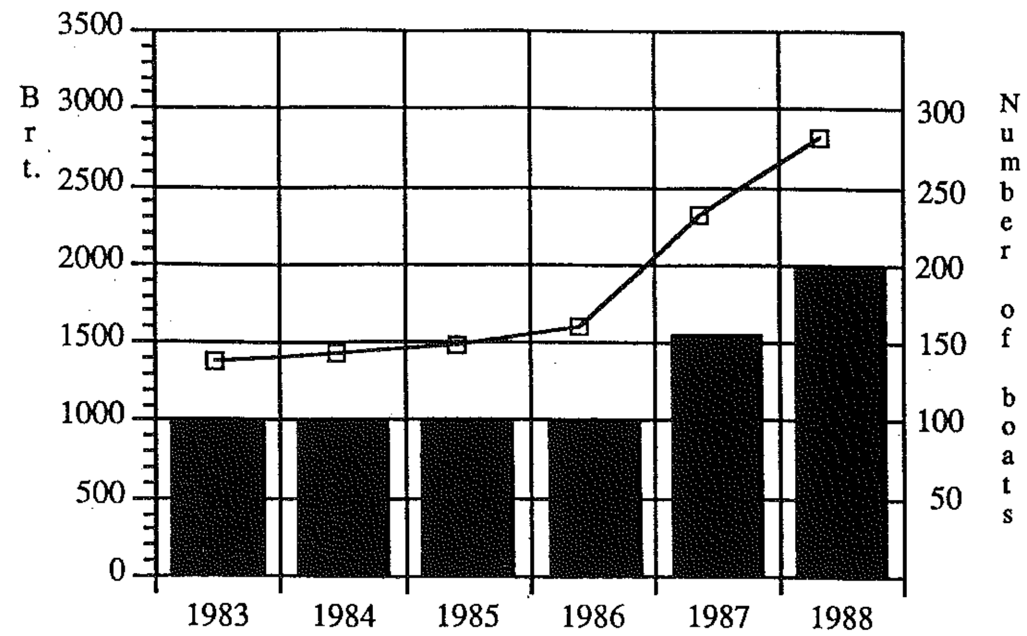
The Icelandic quota system before 1991 did not fulfil any of these conditions entirely. We have already mentioned the loophole about the small boats. The dramatic increase in the number of these very small fishing vessels can be read from the continuous curve in Figure 7. Furthermore, the quota allocation was based only on temporary laws, and the future of the system has never been secure. And, thirdly, only after 1988 could there be any talk about freely transferable quota shares. Consequently, investment in the fishing fleet (and also in processing) continued in the period of the quota management system, as can be read from Figure 6.

The reasons why have been given to some extent, the management system failed to halt investment in the fleet. In addition, there were two other specific reasons First, due to restrictions in funding, normal maintenance had been rather low in the few years before the introduction of the new system. But in 1986 these restrictions were relaxed. This resulted in a maintenance boom, but also partly in a thorough overhaul of the ships. This was wrongly entered in the books as 'investment'. Secondly, about one-fifth of the trawler fleet were transformed from fresh-fish trawlers into freezers. Whether this change has in any way been influenced by the management system itself cannot be decided.

A major reason for the increased investment is the loophole regarding the smallest boats, which were exempted from the management rules for most of the period. Figure 7 shows how the number of small boats increased dramatically.

Figure 7

Investment in small boats of less than 10 GRT. Columns show investment in GRT and the continuous curves shows the number of new boats.



Source: Aegir, No. 7, 1989.

Changes in the allocation of landings

Again, it is difficult to see how or why the management system has influenced the allocation of fresh fish. Certainly the dominating force has been changes in market prices. Freezer trawlers emerged in the Icelandic fishing fleet during this period, and are lately taking as much as 15% of the demersal catch.

Furthermore, export of fresh fish in containers is a new and increasing activity, but whether or not this is a consequence of the management system is an open question. These changes occurred even though there is a penalty built into the system for exporting fresh fish, since there is a quota surcharge of up to 20% for such allocation of the catch.

Enforcement of the system
The Icelandic quota management system has been easy to implement, although the introduction of the vast number of small boats into the system in 1988 called for a greater administrative effort. Registration and enforcement is in the hands of the Ministry of Fishing. The system has called for an additional five people who are mainly engaged in on-the-spot controls. Penalties are of an administrative nature, mainly the temporary withdrawal of fishing licences. Lawsuits have not been necessary. Furthermore, there have been relatively few complaints about the quotas issued. Special cases are treated by a commission consisting of members from the industry and the Ministry. It has succeeded in dealing with all cases.

It is considered that registration of fish landed in Iceland is very accurate and that there is little cheating through unofficial landings. The reports from the vessels are checked against reports from fish buyers. Increased direct export of fresh fish has called for collaboration with foreign buyers, which works satisfactorily.

One of the major problems with individual quota systems is the discard problem, which occurs mainly in connection with by-catches, or if there is a difference in price for fish according to size or quality. Both these factors are partly taken care of in the Icelandic system, the first one by allowing some flexibility in exchanging the quota for one species for another, and simply by the transferability of quotas enabling a fisherman to buy quota rights to cover his eventual by-catch. There are special rules regarding small fish, but it helps that there is very little variation in price by size or quality. The Ministry considers discarding to be a minor problem. The media, however, every now and then report about discards, mainly from the freezer trawlers. A survey conducted among fishermen themselves indicates that about one-tenth of the trawler catches is discarded. However, the validity of this survey has been disputed.[9]

THE NEW QUOTA SYSTEM

A new law on the management of fishing was passed by the Icelandic Parliament in the spring of 1989 and went into force on 1 January, 1991. This is a comprehensive law covering all fishing. The main changes are for demersal fishing:

Elimination of effort quotas. The management system is therefore a pure ITSQ system. There is a certain adjustment in the form of a compensation by which vessels having a quota share less than the average in their classes receive an extra share amounting to 40% of the difference. This adds some 5% to the total quota shares. This is, of course, at the expense of the other vessels. There are restrictions on the transfer of these extra shares for the following 5 years.

All vessels are covered by the system. This means that the exemptions granted to the smallest boats are eliminated. There is a 3 year adaptation period for boats using only hooks.

There are some changes to do with transferability. Basically the transfer of annual quotas remains unchanged. Although in some cases specific permits are needed, experience shows that these are easily obtained. The transfer of permanent quota shares has almost fully liberalized. On the other hand, there is a new clause regarding the sale of vessels out of a community: the community has pre-emptive rights. It is doubtful that this will have any effect. It can be concluded that the quotas and the quota rights are for all practical purposes freely transferable.

A permanent system? For the first time the law governing quota management has no time limit, but it does have a special clause requiring Parliament to take it up and to revise it in two years. We shall come back to this in the next section.

Various changes. The annual quota period is no longer the calendar year but the period from August 31 to September 1 . This change calls for a shorter period in the first year. The possibilities for exchanging the quota for one species for another are somewhat reduced. The same holds for transferring quotas from one period to the next. To a certain extent the quota shares refer to the whole marine resource, i.e. are a kind of *resource quota* and not only single species

[9] The fishermen were asked how much they think *other* fishermen discard.

quotas. Thus the Ministry is allowed to compensate for a severe reduction in the TAC in one species by granting quotas in other species.

PUBLIC DISCUSSION

The quota system was originally accepted by the vessel owners. The fishermen have been more reluctant. Their organisations have never accepted the transferability of the quotas. It must be noted that they have little to say when a vessel owner decides to sell quotas or quota shares; the fishermen get no compensation in these cases.

The political parties have not been united on the quota issue. All the laws have been passed by narrow margins. The latest — and the most important — revision of the law was passed by a margin of only one vote. It is likely that that law will be revised when it is reviewed in two years, but there will be hardly any departure from the basic principle of ITSQ.

Fisheries management has been the subject of many projects and papers at the University of Iceland. Generally speaking the scientists are in favour of the ITQ system. Most of them recommend either a public sale of quotas or at least taxing the quotas, instead of issuing them on a historical basis and without any charge.[10] The arguments are basically economic, some claiming that the reduction of the size of the fleet will be faster that way. Others point to the direct and indirect influences of fishing on other industries in Iceland and claim that only a quota charge can guarantee a normal economic climate for everyone.[11]

[10] Two books were published in 1990, in Icelandic, with popular accounts of these viewpoints. One, *Hagsæld í húfi; Greinar um stjórn fiskveiða*, (T. Helgason and Ö.D. Jónsson, eds., Háskólaútgáfan and Sjávarútvegsstofnun Háskólans, 1990) includes articles by twelve authors. The other, *Fiskistofnarnir við Ísland: Þjóðareign eða ríkiseign* (Stofnun Jóns Þorlákssonar, 1990) is an essay by Hannes H. Gissurarson which contains a different viewpoint.

[11] The author is indebted to Örn D. Jónsson, Director of the Fisheries Research Institute at the University of Iceland, for his assistance in writing this paper.

Nordic Fisheries Management Model
A short description

by

THORKELL HELGASON
University of Iceland, Reykjavik, Iceland

and

STEIN W. WALLACE
Technical University of Norway, Trondheim, Norway

ABSTRACT

This paper describes work in progress on the construction of a Nordic Fisheries Management Model (NFMM), a comprehensive simulation model that will be used to test different methods of fisheries management.

In this model, the fisheries can be managed with various quota schemes, individual vessel quotas or different kinds of total quotas. The individual quotas can be made transferable in the model, with markets for annual quotas as well as quota rights. Among other management tools to be included are closed seasons and general or individual effort limitations.

The fundamental entities in the model are companies engaged in fishing and/or fish processing.

The timescale of the model is theoretically unlimited. The model can be aggregated, for example, by letting a company represent a whole class of vessels.

The model will be written in an objective style, thus making it flexible and reusable. The modelling activity was started at Christian Michelson Institute in Bergen in 1988 but since the autumn of 1990 work has been centered at the University of Iceland.

Initially the project was financed by different Norwegian sources but since mid-1990 the work has been sponsored by the Nordic Council of Ministers and the Icelandic Ministry of Fisheries.

The work has been scheduled to be finished in late 1992.

INTRODUCTION

Fisheries management is evolving rather quickly towards some kind of individual vessel quota. In the North Atlantic area Iceland has had a leading role in this development. Since 1984 the Icelandic fisheries have been managed with a combination of individual catch quotas and effort limitations, but as of 1 January 1991, the Icelandic fisheries have been entirely managed with individual, transferable vessel catch quotas. Canada and Norway have been using quota schemes, together with other systems for managing their fisheries. On the other hand, the member states of the European Community basically rely on total quotas and technical controls.

In Norway the pros and cons of a comprehensive quota system have been much discussed publicly. In 1988 work was initiated at the Christian Michelsen Institute in Bergen to develop a model to simulate the effects of different quota management schemes on the Norwegian demersal fisheries. This initiative was a follow-up of a modelling of the pelagic fisheries (Flam 1983) done earlier at the same institute. Information was also drawn from the experience that had been gained in the construction of a simulation model of the Icelandic demersal fisheries (Helgason and Olafsson 1988). This modelling activity was carried out between 1988 and 1990 at the Haugesund Maritime College and has been documented in several reports (Wallace *et al* 1988, Wallace and Helgasson 1990, Wallace 1990, and Bjelland 1990). However, we shall not elaborate here modelling work in this paper but refer mainly to 4 for a general outline.

As of mid-1990 this modelling activity has been supported by a grant from the Nordic Council of Ministers under a special programme on multi-species research. Simultaneously the model has been redefined and the main activity transferred to the Fisheries Research Institute at the University of Iceland. The Icelandic Ministry of Fisheries is co-sponsoring the project, principally the data collection and adaptation to the Icelandic case, since the Nordic grant covers only general aspects of the modelling work. This current modelling will be referred to as the Nordic Fisheries Management Model (NFMM).

This report describes the purpose of the model and its current status.

THE GOALS AND TARGET GROUP OF THE NFMM

The NFMM is intended to be a tool for practical fisheries managers to test their ideas about changes in their management policies. It is hoped that the model will describe in some detail potential development in the short and long run in fleet size and structure and will predict which temporal and spatial changes will take place in the fisheries. Here we are particularly interested in the effects of fisheries management on regional development.

It should be emphasised that the model is intended for practical use. Therefore, it is important that it is developed in close collaboration with the people engaged in day-to-day management of the fisheries.

Nevertheless it is hoped that the model will also be helpful in research, in particular in connection with multi-species models.

THE BASIC STRUCTURE OF THE MODEL

The model simulates the behaviour of an entire fishing fleet over a period of several years under a certain management regime and given economic externalities.

As regards management regimes, the focus is on different catch quota systems, ranging from total quotas only to permanent but transferable individual vessel quotas. Great flexibility in the definition of quotas is emphasised. Thus vessel quotas may be combined with group quotas, whereby certain classes of vessels, say trawlers, share a common quota which may be smaller than the sum of quotas of the individual trawlers. Similarly, different levels of restrictions on transferring quotas may be included.

In addition to catch quotas, different kinds of effort limitations will be taken into consideration.

The main emphasis will be correctly imitating the behaviour of the fishing firms correctly. In many cases there is a high degree of vertical integration in the industry. Thus, in Iceland, about 80% of the fishing fleet is owned by the processing industry. Therefore it is considered necessary to include fish processing and fish markets in the model, although in the beginning the processing part will be modelled rather naively.

The biology is self-contained. In the first version it will be elementary and based upon a single species model; hence there will be no ecological feed-back. Provision is made for extending the corresponding modules in such a way as to encompass various factors, such as stock dependent growth.

The model is basically deterministic, but provision will be made for introducing randomness — for example in the biology and in the catch rates.

MODEL ELEMENTS AND THEIR INTERRELATIONSHIP

In this section we give a short overview of the main elements or objects of the model. The model includes the effects of short-term, medium-term and long-term decisions. Short-term decisions include decisions regarding a single fishing trip or decisions on how to process the current landings. Medium-term decisions deal with the buying and selling of quotas and the choosing of fisheries for

the boats. Medium-term refers to a year or to the remainder of the current management year. Long-term decisions deal mainly with investments or trading in boats or quota rights.

Authorities is the module in the model taking care of all fisheries management. It opens and closes fisheries, issues quotas (or sells them). It keeps books on all quota rights, both in individual and hierarchic quota systems.

Companies, i.e. fishing firms, are the basic entities of the model. Generally a company owns one or more fishing vessels and/or processing facilities. When applied to a real situation, say in Iceland, the companies of the model will be images of real fishing enterprises of which there are some 400. The smallest ones will be eventually grouped together in the model into fictitious aggregated companies. The activities of a company include advising its boats about choice of fisheries and landings, its processing plants (if any), selling and buying fish (if engaged in processing), and trading in quotas and quota rights (if applicable). The companies in the model are basically profit motivated. This effect will be described by a simple linear optimization model for each company to make medium-term decisions. Short-term decisions will be rather straightforward, to begin with. But after the processing has been incorporated, the product mix and dealings on the fish markets again will be modelled with a linear model. Long-term decisions will be based upon the medium-term decision process. Thus investment in, say, quota rights will be based upon experience, whereby it will be calculated whether the company would have been better off with a permanent quota rather than renting annual quotas on the spot market. At a later stage, some long-term planning may be adopted.

Boats, or vessels, are related to companies. Thus, they do not have an independent decision-making capability. Some intelligence may be added at a later stage, especially regarding short-term decisions. The boats accept messages from the companies on what to do. Basically the boats operate tour by tour, but that does not exclude the simpler continuous simulation.

Fishery is a homogeneous fishing activity in area, gear and vessel type but not necessarily in vessel size. Boats engage in one fishery at a time. One of the main decisions each company must make is to select fisheries for its boats.

Stocks are the biological fish stocks from which the catches are taken. They are renewable according to the biological formulae incorporated in that object. Quotas can be issued on stocks or on units smaller than stocks. This flexibility is needed, for example, in the Norwegian cod fisheries where quotas for the Barents Sea might be different from those for the Lofoten area.

Quota markets are of two kinds, rental markets where companies buy and sell annual quotas, and markets for permanent quota rights. Marketing will take place periodically in the model and will basically be cleared at each event. This will involve an iteration process which may slow down the model. Thus we may have to be content with only a partial clearing of the markets.

Fish markets will be included in the model as internal objects, but initially they will be treated as external, which means that they accept any externally given amount of fish at a given price.

IMPLEMENTATION

The model is being developed in the object-oriented programming fashion and written in C++. Object-oriented programming is highly realistic. Every entity or object of the model describes a real activity, such as a fishing vessel and its operation. Object-oriented programming enables flexibility and decentralized work. Once it has been decided which messages each object must be capable of handling, the objects can be developed further independently of each other. It is easy to define different objects of the same class. Thus there may be different kinds of company objects as, for example, for modelling companies with different types of profit motivation.

To some extent, different management options will be selected by choosing proper parameters. On the other hand, full flexibility will be achieved by constructing different authority modules or objects. A portfolio of such will be included with the model, but since the model-makers probably will not foresee all the possibilities, the object-oriented approach will make it easy to develop special objects at the request of each customer.

The model is being developed on a SUN workstation under the UNIX operating system. It is hoped that the final version of the model also can be run on such a workstation.

The model will be menu-driven and great emphasis will be laid upon graphic and visual output.

DATA

The model will require considerable data collection and analysis. (See [7] for preliminary study on the analysis of fishing cost.) This must be the responsibility of each user. However, we hope that the experience gained in the first implementation (for the Icelandic fisheries) will be helpful to other users.

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The experience of the ITQ-system in Iceland. The development of the fleet and trade in the quota market

by

ÁSGEIR DANÍELSSON
National Economic Institute, Reykjavik, Iceland

and

ÓLAFUR ÖRN KLEMENSSON
Central Bank of Iceland, Reykjavik, Iceland

ABSTRACT

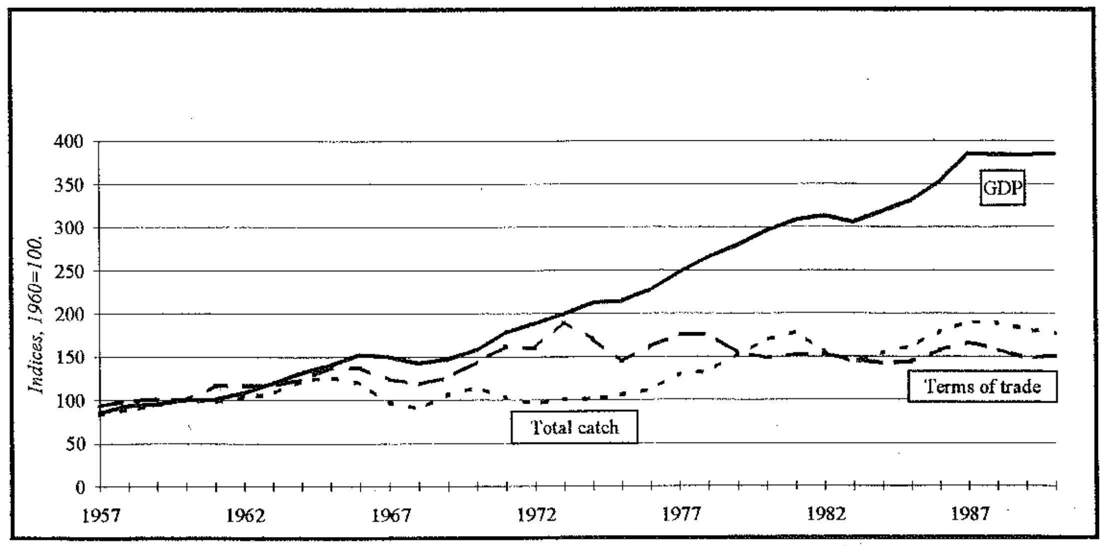
In this paper we discuss the Icelandic experience of managing fisheries through an ITQ-system. In the first section we give an indication of the importance of the fisheries for the Icelandic economy. In the second section we discuss the reasons why it is necessary to manage the fisheries. In the third section we describe the main characteristics of the Icelandic ITQs-sytem and how it has evolved. In the fourth section we discuss development of the fleet and in the final section we describe the trade in quotas in Iceland, the volume of quotas traded and the main types of exchanges that take place.

1. The Icelandic fisheries

For many years the fisheries policy has been at the centre of public debate in Iceland. Since the fisheries sector is of fundamental importance in the Icelandic economy, this is not surprising. Fish products account for some 70% of exports. Even though only 13% of the working population works in the fisheries and the fisheries contribute some 17% to the GDP, its fundamental importance can be seen by the macroeconomic impact and its role in Icelands economic growth and development. Figures 1 and 2 show this. In Figure 1 we have plotted the total catch at fixed prices, the terms of trade of goods exported from and imported to Iceland, and the GDP at fixed prices.

Figure 1

The total catch, the terms of trade and the GDP at fixed prices 1957-1990



A simple regression can also be used to show the importance of the fisheries sector. We found that the equation (t-ratios are in the parenthesis):

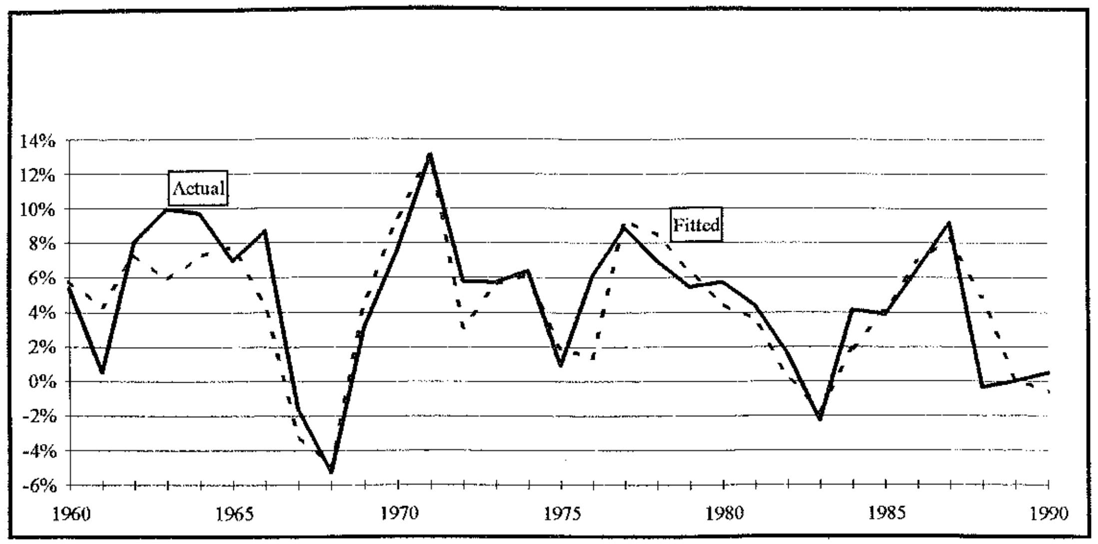
$$\underset{}{DGDP} = \underset{(4.07)}{0.26*DCATCH} + \underset{(2.52)}{0.15*DCATCH(-1)} + \underset{(1.54)}{0.10*DToT}$$

$$+\underset{(3.51)}{0.22*DToT(-1)} + \underset{(1.44)}{0.096*DToT(-2)} + \underset{(4.27)}{0.024}$$

fitted with OLS explained some 72% of the total variation in the growth rates of GDP. Figure 2 shows the actual changes in the GDP and the changes which the above equation predicted.

Figure 2

Percentage changes in GDP 1960-1990. Actual and fitted values



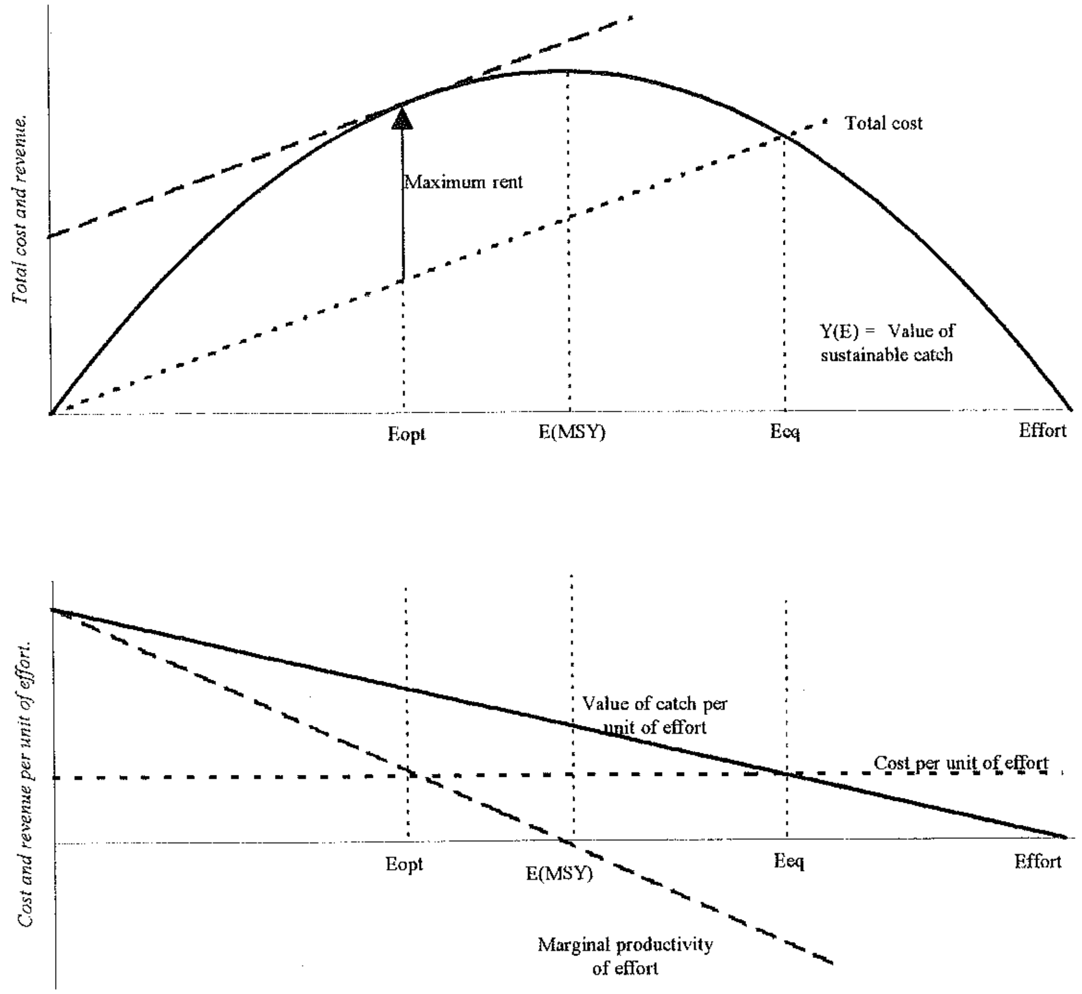
The size and importance of the fisheries sector makes Iceland the only country in Europe where the fisheries form the economic basis of an independent monetary and fiscal system and an independent state. Iceland is the only country in Europe where the exchange rate and monetary and fiscal policy depend primarily on the fisheries. Since the fisheries is the most important sector of the economy, and the one that is most competitive in international markets, its performance is of crucial importance for the Icelandic economy. No other sector of the economy can cushion the effects of one bad harvest or of bad management of the fisheries.

2. Why fishing effort must be controlled

The need to regulate the fisheries stems from the fact that the resources of the sea are a common good. If the fisheries was to be left on its own, there would be a strong tendency to expand the effort beyond what is biologically and economically optimal. It is therefore not possible to achieve the optimal allocation of the productive resources through the automatic mechanism of the market. The standard Schaefer fisheries model shown in Figure 3 illustrates this phenomenon.

The upper part shows the total costs, revenues and the value of the sustainable catch, while the lower part shows the marginal productivity. The optimal effort is at Eopt, where the marginal productivity is equal to the marginal cost. When the natural resources of the sea are free, there is strong tendency to expand the fishing effort beyond the the optimal level (Eopt). The reason is that the individual fishermen find it rational to increase effort and fishing capacity as long as the total effort is less than the equilibrium effort (Eeq.). There is a difference between sustainable marginal productivity and the individual marginal productivity as the fisherman sees it. The reason is the scarcity of resources. Expanding the effort initially will increase the total catch, but as this goes on, the fishing stocks will be depleted and the catch per unit of effort will be diminished. When there is free access, the fishing capacity will outgrow the productivity of the natural resources of the sea, in some cases until the fish stock collapses. The limitation of the productivity of the seas' fish stocks must be taken into account by regulating the fishing effort.

Figure 3



The danger of overfishing in a free access system stems from the fact that the fishing grounds are a common property. If the fish resources were private property (e.g. allocated to a limited group of fishermen), this would not happen. Restriction of the access is therefore a prerequisite for achieving the optimum level of effort and extracting the largest possible economic rent. The rent is equal to the difference between the catch per unit of effort and the cost per unit of effort. This rent also would be equal to the price for the exclusive fishing rights if these rights were sold in a market.

3. The ITQ-system in Iceland[1]

The collapse of the Norwegian-Icelandic herring stock in 1967-68 alerted Icelanders of the fact that the seas resources are not unlimited. In 1976 Icelandic Institute for Marine Research (IIMR) published a report on the situation of the cod stock. The Institute warned that the spawning stock of cod was dangerously small.

In the early 1970s there were great investments in fleet capacity. During the previous period there had been a lot of investment in vessels suitable for fishing herring, but few vessels were suited for fishing groundfish, and there were few trawlers. The new trawlers that were bought during the early 1970s were able to go out and fish in bad winter weather and secure raw material for the processing plants on a more regular basis than had been possible previously. In many villages, especially on the northern coast, the trawlers transformed the employment situation, creating relatively stable

[1] For a more comprehensive description of the Icelandic ITQ-system see the paper 'The Icelandic Quota Management System' by Professor Thorkell Helgason. This paper will be presented at the third annual meeting of EAFE in Dublin, April 1991.

employment all year around. The new trawlers and the extension of the Exclusive Fishing Zone to 50 miles in 1972 and to 200 miles in 1976 led to even bigger catches. But, as it happened, this new wave of investment was excessive and led to a considerable overinvestment in fleet capacity. Nearly 60 new and techically superior trawlers had been coming into the fleet in the period 1970-1976 and more were to come. The overcapacity of the fishing fleet became evident and some measures had to be taken to reduce effort.

At first the authorities tried to reduce effort through limiting the time during which gill-netters were allowed to fish. The trawlers were not allowed to catch cod at certain times of the year. Compulsory stoppages in harbour were prolonged. This method of regulation was in force until 1983, but as a method for decreasing the fishing effort it turned out to be ineffective. First, catches continued to exceed the TACs. Secondly, it led to a big increase in the effort to fish species other than cod, so much that it nearly led to the depletion of some stocks. Thirdly, the system did not make the fisheries more efficient.

The second step in the management of the Icelandic fisheries was taken in 1984. New laws concerning the management of the fisheries were passed during 1983 and implemented the next year. The system was to cover the fishing of the most important groundfish species and the fishing of capelin and herring. The scheme was in three parts. First there was the system of catch quotas which were allocated to individual vessels, secondly there was the system of effort quotas, which allocated the number of days that the vessels which opted for the effort quotas, were allowed to fish and thirdly there were the small boats where the system of free access continued,(The upper limit defining a small boat was set at 10 GRT in 1984, and reduced to 6 GRT in 1988). The new laws also introduced a comprehensive ban on entering a new fishing vessel which was bigger than 10 GRT, except when a similar vessel had been scrapped or sold abroad. This regulation, which is still in force, seems to have been effective.

The new law allowed fishing vessels 10 GRT or bigger to choose between catch quotas based on their catch-record during 1981-83 (or the most recent three-year period), and effort quotas. It also permitted trade in catch quotas with certain limitations. A vessel could sell or buy some quota for use within the year, i.e. renting quotas within the year was permitted. But as the vessel and its catch record was the reference point for the allocation of the catch quotas between the vessels it was not possible to rent the quotas permanently or sell them. Only by buying a vessel with quota-rights and transfering these quota rights to another vessel, was it possible to transfer quota-rights permanently between two vessels.

In 1990 the Icelandic Parliament passed a new law for managing the fisheries. The main changes were the following:

1. All regulation of the fishing effort should be through a system of catch quotas. This system was to cover the most important species and the Minister of Fisheries had the power to introduce this system for other species if they were in danger of being overexploited.
2. The system was to be comprehensive and included all fishing vessels, including the smallest boats.
3. The system was to get a more permanent basis. Therefore the law did not include a clause where an expiry date was specified, as previous laws had. The law is to be revised before the end of 1992.
4. The transferability of the quotas was to be increased and for the first time selling quota-rights was permitted, i.e. the right to get a quota allocation could be sold and bought. The renting of quotas during one or more periods, without selling the right to future quota allocation, was permitted as before.

The last two points were intended to make the quota rights into property rights to solve the common property problem of the free access fisheries and create ,an efficient market system for this sector of the economy. It is though important to note that the law has not taken the full step towards introducing property rights for the natural resources which the fishing sector utilizes. The first article of the new law stipulates that the resources of the sea are a common property of the Icelandic

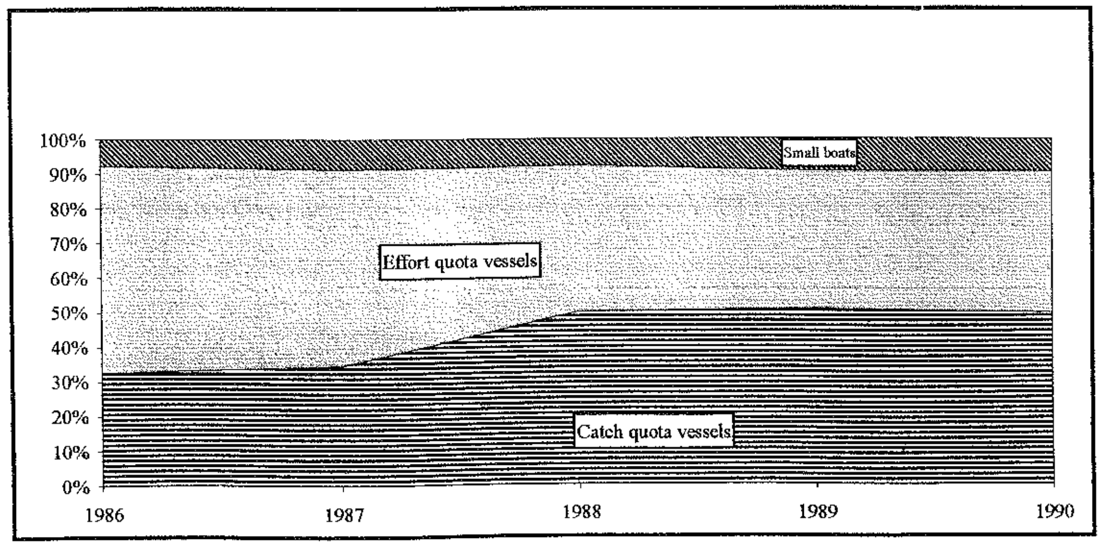
nation. This property is now being given away to indivdual owners of fishing vessels, who are allowed to sell them for their own profit.

4. The experience of the system 1984-1990

When the law was first implemented in 1984, most of the vessels chose the catch quota. One reason for this was that the stocks were at a rather low level in 1983-84. In 1985 a majority of the vessels again opted for the catch quotas, but in 1986 the vessels operating within the effort quota system caught more than 50% of the groundfish species regulated by the quota system. Nevertheless their share declined gradually during the period 1986-1988, as Figure 4 shows.

Figure 4

Catches of groundfish by vessels choosing different quota-systems



It was to be expected that the effort quota system would gradually become less important. In the beginning some vessel-owners would find that they could do better than they had done during the reference period 1981-83 and opt for the effort quota system. But after having had their ability to fish re-evaluated through the effort quota system, it was rational for them to go over to the catch quota system where they were allowed to fish their quotas with the minimum cost. New boats would be tried out in the effort quota system and then return to the catch quota system.

It is very difficult to implement the rule that a new fishing vessel should be allowed to enter the system only if a comparable vessel has been scrapped or sold abroad. It is therefore to be expected that some vessel-owners would be able to get a new and better vessel into the system, increase its quota share in the effort quota system and then return to the catch quota system with an increased share. This was bound to lead to discontent among the majority of fishermen, who easily understood that their quotas were decreasing because bigger quotas were allocated to the vessels which successfully utilised the effort quota system. A vessel which permanently stayed in the catch quota system saw its share of the catch actually decline. This loophole in the system did not lead to big transfers of quotas from the vessels which stayed in the catch quota system, but it caused to a lot of dissatisfaction among the fishermen.

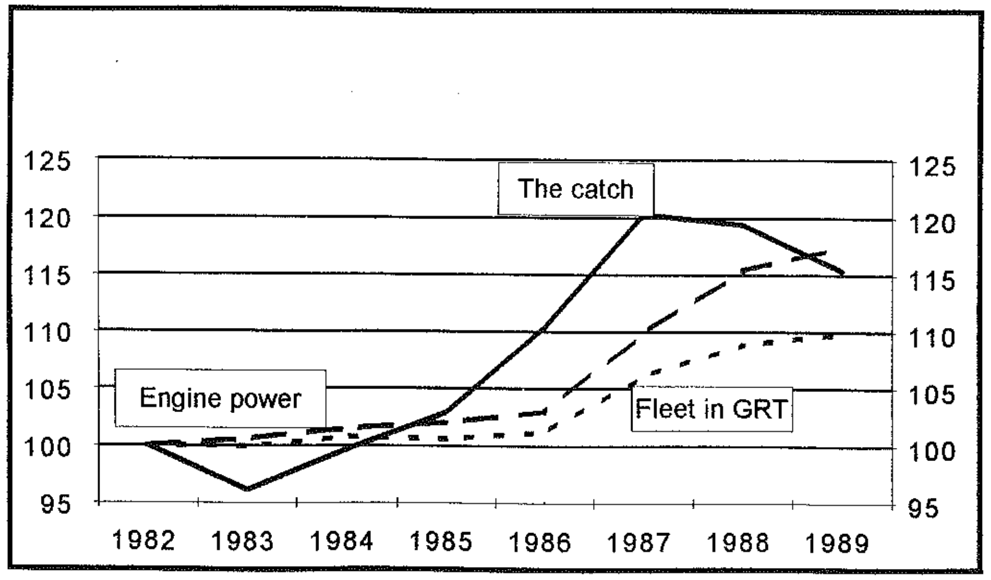
In Iceland, the experts tend to prefer the catch quota system to the effort quota system. In the former, the cost of catching is minimized and the possibility of planning the fishing activity is greater. It is also believed that the side effects of the catch quota system are relatively unimportant. Unreported landings are practically impossible and 'throwing' at sea is believed to be relatively little.

The system from 1983 was effective in halting the increase in the number of fishing vessels in the system. In 1984 there were 681 fishing vessel which operated in the quota system, but in 1990 there were 629. At the same time, the number of small boats, i.e. boats of under 10 GRT, which were not included in the quota system increased from 1128 in 1984 to 2023 in 1990. As can be seen from Figure 4 the small boats increased their share of the catch of groundfish which was regulated by the quotas only marginally, or from 7.7% in 1986 to 9.3% in 1990. This was a loophole in the system which the fishermen on the bigger vessels did not like.

Even if the system from 1983 was effective in halting the increase in the number of bigger fishing vessels, it did not stop the growth in the size of the fleet in terms of GRT or in terms of engine power. Figure 5 shows this.

Figure 5

The total catch, the fishing fleet in GRT and the engine power. Indices, 1982 = 100



It is worth stressing that Figure 5 shows the size of the registered fleet, not the size of the fleet that is being operated. In the transferable quota system, a firm with excess capacity does transfer the quotas from its least effective vessel to the others and in that way it tries to use its resources more effectively. But the firm does not sell or scrap the excess vessel because this vessel has a value as a part of the quota system. It can be used to allow a new vessel into the system. It is also worth noting that the stocks around Iceland are presently at a rather low level, so it is therefore to be expected that in the future (though not the very near future) the catch quotas will be increased.

There are several known cases where firms have decided to transfer all quotas from one of its vessels (even big vessels like trawlers) without actually selling or scrapping it. But, unfortunately, there are no figures which show the extent of this practice. Most often one finds this practice applied within a firm which owns several vessels and can catch its quota with fewer vessels. For the smaller firms, the indivisibility of the vessels becomes a problem, especially for those firms that are involved in fish processing as well as in the selling of quotas for this can then mean less raw material for the processing plant, and less employment in the village. It is interesting to note that there are already cases where a firm in Village A with excess fleet capacity has made an agreement with a firm in Village B to transfer some quota from the former to the latter in exchange for landing the fish caught on the transfered quota plus some additional catch in Village A. In that way, Village A will lose some quotas but gain some landings at the expense of Village B, which has gained some quota.

THE TRADE[2] IN QUOTAS

As we mentioned earlier, most vessels opted for the catch quota system in 1984 and 1985 when that system started. It is therefore not surprising to find that the volume of quotas traded actually

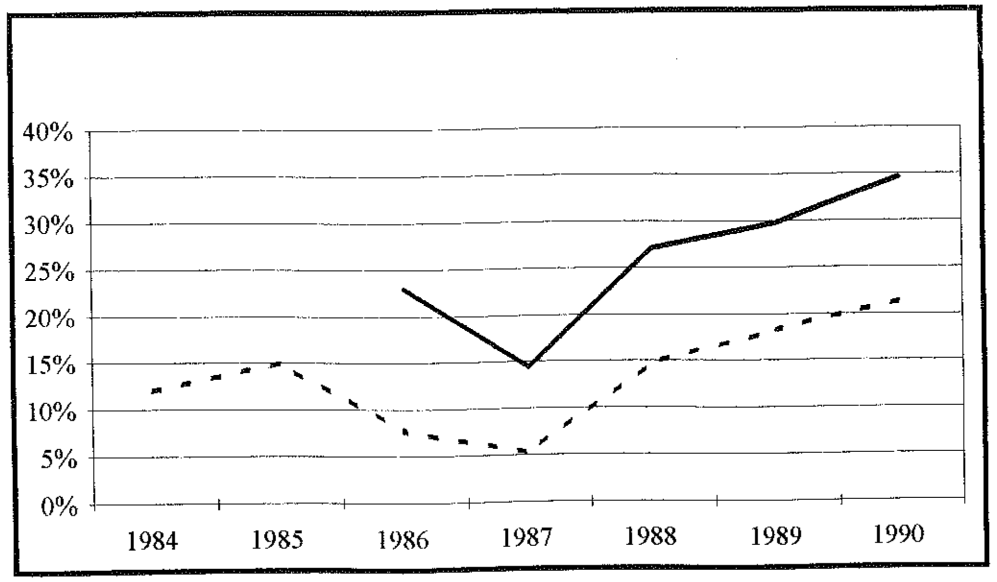
[2] Traded or transfered. We will include here quotas transfered beween vessels owned by the same firm. Below we will show the relative size of the different types of quota transfers.

decreased in 1986 when many vessels went over to the effort quota system and when the cod stock recovered and quotas for cod were increased. This is shown in figure 6, where the upper line shows the ratio of the volume of the groundfish quotas traded each year and the total volume of catch quotas for groundfish allocated during that year. The lower line shows the ratio of the volume groundfish and shrimp quota traded each year and the total catch of these species during each year.

In this paper we discuss only trade in groundfish and shrimp quota. Beside these species the capelin, herring and the fishing of some crustaceans are managed within an ITQ system. But there have been efforts taken to keep the capelin and the herring fishing to certain vessels. This is one of the reasons why trading in these quotas is limited.

Figure 6

The size of the trade in quotas



From 1988, the volume of quotas traded each year has been increasing rapidly and reached 35% of the allocated catch quotas in 1990. The cuts in the groundfish quotas each year from 1988-1990 contributed certainly to this development. When a vessel owner doesn't have enough quotas for his vessel he starts to look for the most efficient ways to utilise his resources and not surprisingly he often finds that he can improve his efficiency by changing the original allocation of quotas which is decided by crude administrative methods.

A second factor which contributed to this increase in the quota-trade was that the vessel-owners began to see the new system as a permanent part of their economic environment and began to adjust to it. In the beginning there was a lot of prejudices against trading in quotas. Many fishermen, and a lot of others as well, thought that it was immoral to 'sell the fish in the sea before it was caught'. There were also those who thought that if they sold some quota and consequently they would catch less, then there might come along some Minister of Fisheries which decided on a new reference period for the allocation of quotas. Someone who sold part of his quota would be suspected of not being able to catch all of it and would therefore not be entitled to it on a permanent basis.

There are obviously many reasons why vessel-owners sell and buy quotas. Some have some quotas for a species which it is difficult to catch from the harbour where the vessel is located. In that way a vessel-owner on the south who owns some shrimp quota may decide to sell it to the north where the vessels are better located for catching shrimp. Some may have such a small quota for some species that it does not pay to buy the necessary gear to catch it. In that way the number of vessels which caught some shrimp in 1989 was 184 but 251 had some shrimp quota allocated to them. In 1990 these figures were 175 and 246.

It is more difficult to specify the reasons behind the trading in groundfish. Some of it may be because catching of different groundfish species has developed differently in different parts of the country. Some of it may be because of efforts to rationalise and keep some vessels out of operation for a part of the year or for the whole year. Accidents accounts for some, etc. It is also the main argument for allowing trading in quotas that it is impossible to foresee all the ways that trading in quotas can improve efficiency.

The Ministry of Fisheries in Iceland classifies the transfers of quotas into four categories. In the first category (called A) there are transfers of quotas between vessels which are owned by the same firm. In the second category (B) there are transfers of quotas between vessels which are registered in the same harbour. In the third category (C) there are transfers of quotas between vessels registered in different harbours, but where the trading is based on exchanges of quotas of equal value. In the fourth category (D) there are other transfers of quotas between vessels registered in different harbours (i.e. other than those in C). Figure 7 shows the relative share of these different categories.

Figure 7
The shares of different types of trade in catch quotas in Iceland

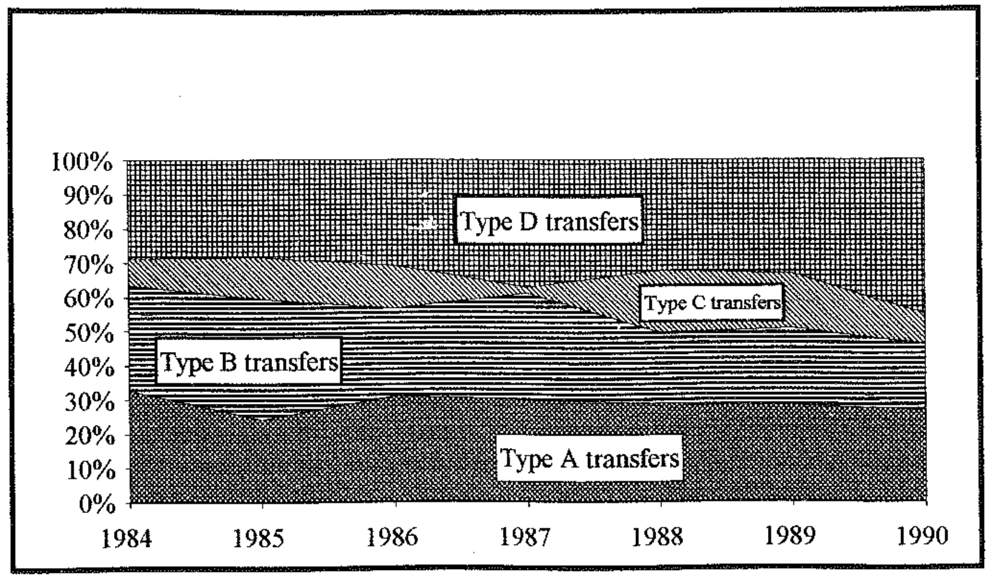


Figure 7 shows that the category D transfers have been on the increase while category B has been decreasing. This seems natural development of the quota trade. It takes time for the vessel-owners to learn to operate in this new environment and get information about the possible quota deals. They naturally start with other vessels in the same harbour and then gradually learn about other possibilities. As transfers of type D are the ones which had to be formally approved by the local authorities its increase reflects probably also that the local authorities were learning about the quota system as well.

The law that was in effect before 1991 stipulated that the local authorities had to approve of all quota transfers of category D (except for shrimp, which opened up certain possibilities, which suprisingly few utilised). It seems that the local authorities have in most cases approved the quota transfers. The new law stipulated that local authorities have to be informed about quotas sold to someone in other municipalities, and that the local authorities have the first option to buy a fishing vessel which is to be sold to someone in another municipality.

It is to be expected that transfers of category A are preferred by the vessel-owners. It is though difficult to tell what should be the share of this type of transfers when the trading is optimal. As many firms in Iceland own more than one vessel there is considerable scope for transfers between vessels owned by the same firm. During 1989 and 1990 the vessels owned by firms that owned more than one vessel had 40% of the catch quota for groundfish and shrimp.

The Producer's Organizations and the Autoregulation Problem in Mediterranean Littoral Fisheries

by

RAMON FRANQUESA
Faculty of Economics, University of Barcelona, Barcelona, Spain

and

RAFAEL LOSTADO
Faculty of Economics, University of Valencia, Valencia, Spain

ABSTRACT

This paper evaluates role of the Fisheries *Cofradías* (guilds) in the management and control of the littoral fisheries in the Mediterranean and the potential cost that the loss of some of their role and skills could have, in view of the establishment of Producers Organisations.

1. Introduction

In this paper we shall emphasize the difference between the fishing structures of the Mediterranean and the Atlantic. This distinction is not based on technological backwardness or on a lack of investment, but on the different use of resources: a greater variety of species, more widely dispersed and with greater market value. Because of this divergence, it seems logical to deduce that the European Community needs to apply different policies to different fishing grounds. We shall deal specifically with the conflicts which can arise as a result of exporting to the Mediterranean a policy of fishery organisation designed for the Atlantic.

One of the most important effects of the fishing association is its capacity to regulate the exploitation of fishing resources. The stronger the association, the closer the similarity between the behaviour of the fishing communities and the theoretical behaviour of the sole propietor of the resources and the weaker the association, the closer the similarity in behaviour to exploitation by free access.

When the level of technology creates over-fishing through free access, this aspect becomes crucial for any rational operation. All the indications are that this is what is taking place in the Mediterranean.

If we apply the methodology introduced in our study[1] commissioned by the EC, we can conclude that the net income of the fishing companies on the Catalonian coast is now practically equivalent to the subsidy they receive allotted to fuel stands out at 65% of the total subsidy. This does not include the various items of credit which the sector receives at very favourable rates, and does not take into account the public cost of surveillance, or the cost of the institutions that carry out of fishing policy in the regions, the state and the European Community. A similar situation exists in the rest of the Spanish Mediterranean, but reliable data are available only for Catalonia.

The subsidies came about in the 1960's as a result of pressure from the fishing sector, which in the short term benefited since this reduced their costs. In those years the fishing policies for the Atlantic were extended to the Mediterranean. The subsidies, which were given to deep-sea fishermen to assist their access to international waters also became a general practice in coastal fishing. Since then, the problem of over-investment in these fishing grounds has worsened. Practically all the fishing grounds in the Mediterranean are coastal and it is here, that the worst problems have occurred.

[1] R. Franquesa and R. Lostado "Estudio Economico de la pesqueria de Cataluña y Valencia", Vol. II, Cap. 11, en J. Lleonart (director), 1990, *La pesqueria de Cataluña y Valencia: descripcion global y planteamiento de bases para su seguimiento*, Reference CSIS No. 279, financed by DG XIV of the EEC.

TABLE 1

Profits and aid in Catalonia for 1989 (millions of pesetas)

(A) Production accounts	
Gross Income for sales	18,009
Salaries, Fuel, Victualling	−12,254
Gross Exploitation Margin	5,755
Gross exploitation margin	5,755
Maintenance Cost	−2,820
Estimated net Profitability	2,935
(B) Administrative supports	
Fuel Subsidy	1,850
Salary for Guild (Cofradias) staff	200
Direct aid DGP	240
ECC: Port structure	437
Financing of computerisation	30u
Ship building EEC/MAPA	33
Ship Modernisation EEC/MAPA	41
Total Administrative financing	2,831
(C) Real Profitability	
Estimated net Profitability	2,935
Administrative financing	2,831
Real net Profitability	104
(D) Other Supports	
Preference Credits ICCA	1,613

The figures for profitability and subsidies provide us with information on three of the crucial issues in the present situation in the Spanish Mediterranean.

Firstly, the administration creates incentives for investment, specifically for the type of investment that encourages technology with high fuel consuption (trawling), this leads to the deregulation of the operation and encourages its expansion in an over-fishing situation.

Secondly, the administration is heavily conditioned, from the social point of view, to manage things for the short term. It would be difficult to make quick changes because the fishing sector is now dependent for its survival on subsidies.

Thirdly, the current amount spent on aid suggests that it would not be rational to increase expenditure in at this sector; neither does it seem prudent to direct significant funds to the establishment of a solid policing body if the cost overrides the potential profit.

We find ourselves in a situation where one end of the sector on the one hand is trying to regulate itself in order to rationalise the operation (bans on fishing, port controls, and so on), but on the other hand is receiving signals from the market, based on the existence of large government subsidies, which incourages it to increase the efforts. This is the delicate state of affairs in which the Spanish Mediterranean fisheries currently find themselves. We shall now analyse each aspect of this situation.

2. Surveillance versus self-regulation in the fishing sector

We shall consider two ways of managing and controlling the fisheries: in the first place, the regulation of fishing activities by bodies external to the sector[2] (the navy, regional surveillance units) Masipcosin, 1987; secondly, the system that controls the sector by self-regulation, with the possibility of resorting to the administration to ensure a common framework of reference. External regulation is established through a surveillance system by which the administration (through means, staff sanctions, statistics and so on) controls the implementation of its own rules.

As a result of this distinction, there is a dilemma: whether the sector should be regulated by the administration or whether it should regulate itself. The first system would entail the additional expense of surveillance, which would have to be justified by, and proportional to, the sector's profitability. The second case would mean that, in the last resort, the administration would hand over the management of state property to the fishing sector.

In considering the case for self-regulation, we must first consider whether there exist forms of independent organisation within the fishing sector capable of rationally controlling operations. Therefore, in order to examine up to what point self-regulation could substitute or complement the administrative surveillance, we must start by looking at the organisational forms adopted by the sector.

3. Self-Organising Structures in the Fishing Sector

Both public and private organising bodies work within the same fishing sector. Different types of associations (guilds, - cofradias -, co-operatives, trade unions and producers organisations) have emerged in the Spanish fishing sector to cope with the mounting degree of specialisation among the various fleets and ways of fishing, or in response to changes in the law.

We shall now examine the guilds (cofradias) and producers' organisations, because within their constitutional objectives, both of the organisations aim to regulate the explotation of natural fishing resources.

3. (a) *The fishing guilds* (Cofradias)

Guilds came about at the end of the eleventh century to provide cooperation and mutual assistance for their members.[3] Nowadays membership is limited to owners and fishermen of fishing vessels of less than 150 Gross Registered Tonnes (GRT), which mostly engage in coastal fishing.

The Guilds' legal status[4] is that of a public corporation which can operate as a consulting body and collaborate with the fishing administration. Guilds are free to organise their own constitution and membership. The cost of their activities is covered by membership fees and by the payment of a percentage of all the fish sold on the fish market.

The basic characteristics of the guilds are as follows:

- Family ownership or joint ownership of property.
- The distribution of income is carried out 'by shares'. That is the vessel owner first deducts the fixed cost of operating the fishing boat and then distributes the net profit in proportional 'shares' which make up a 'salary'.
- Fishing is carried out in fairly stable fishing grounds, managed by the respective guilds.
- The guild port is the usual workplace for the guild's members, and members usually sell their fresh produce there.

[2] J. Masip Cosin, 1987, "La vigilancia es una inversion. Un ejemplo práctico". *Investigaciones Pesqueras* núm 51, Supl. 2: pp. 55-64.
[3] F. Galindo and F. Lozano, 1988, "Estructuras organizativas del sector pesquero español", *Información Comercial Española*, num. 653-654, pag. 55.
[4] Real Decreto 670/1978 de 11 de marzo. Anon. 1978 Royal Decree 670/1978 of 11th March.

- The complex fiscal laws operating in any modern economy, the low cultural level of the fishermen and the limited size of family operations enable the guilds to take over the administration and management of its members' affairs.

These characteristics have arisen mostly because the guilds oversee coastal fishing. This is the only type of fishing carried out in the North-West Mediterranean (Valencia and Catalonia), it is regulated by 22 guilds in Valencia and 29 in Catalonia. Timetables in this area established by the respective guilds, in blocks of 12 hours a day, from Monday to Friday.

3. (b) *Producers'Organisations*

The roots of the producers' organisations are in the EC organisations, set up within the framework of the Common Agricultural Policy for the agricultural product that are the hardest to sell. The extension of price policies to the fishing sector, invloved the standardisation of products and the creation of organisational structures for which producers made themselves became responsible. These structures became the producers' organisations.

They were set up in 1970[5] to rationalise the fishing industry. They are empowered to establish plans for fish catching, to centralise sales offer, to apply a pricing system (basically, by withdrawing excess produce at a guaranteed price) and to improve selling conditions.

These organisations must be recognised by the administration[6] and must be set up on the producer's own initiative. However, the concept of a 'producer' has not been clearly defined. In practice, the 'producer' is someone who earns an income from the capture and sale of fish. In the case of coastal fishing, where the crew and the vessel owner share the produce, either could be considered to be the producer. However, officially, the EC considers that producers' organisations should be made up solely of vessel owners.

Membership of a producer's organisation means that members must sell all their produce through the organisation and must accept the established rules of sale and production.

3. (c) *The setting up of producer's organisations in Spain*

As a member state of the EC, Spain has had to alter its structures quickly. This process has resulted in some contradictions between the traditional guilds and the new producers' organisations.

In the North-West Mediterranean the producers' organisations have been created in the bosoms of the guilds. They have had to adapt their constitutions in order to comply with Community norms. They are exist as institutions in order to benefit from the Common Fishing Policy. In reality, the producer's organisations are a mere façade. They have administrative powers but are in fact, controlled by the Guilds. Once again, pragmatism has imposed itself on the Administration's bureaucratic directives.

The fishing guilds have dodged the official obstacles inherited from their status as public bodies. We can therefore assert that the Spanish coastal fishing producer's organisations are being built on the foundations of the guilds and, specifically with reference to the Mediterranean, on the provincial federations of these guilds.

The fact that the guilds and the POs have similar powers and objectives should not obscure their differences:

(a) While all fishermen are grouped together under the guilds, the POs only bring together the vessel-owners. However, the profitability of coastal fishing is due to the direct participation of owners and employees, a situation which makes a system of salaries[7] unfeasible. It is

[5] Reglamento CEE 2142/70. After this the proposed characteristics remained constant throughout the base regulations published in 1976 (Reglamento CEE 100/76) and in 1981 (Reglamento CEE 2796/81). Anon., 1979.
[6] Reglamento CEE 2062/80. Anon., 1980.
[7] R. Franquesa, 1987, *Teories sobre l'explotació dels recursos naturals renovables. Una aplicatió al cas de la pesca a Catalunya,* Doctoral Thesis, Universitat de Barcelona, Vol. I, pag. 134-136.

hard to imagine that the fishermen will accept any association which does not recognise the right to participate in the working out of self-regulating norms. Self-regulation is based on the effectiveness of the agreements, signed by all those who take part in the operation. Given the characteristics of coastal fishing, it is hard to imagine that any agreement could be viable without the participation of all the fishermen.

(b) The guilds control the entire production all species in a given geographical area. The organisational structure of the POs exploits a particular type of fishing ground, a fact that gives rise to a potential disagreement; if the various arts of fishing come into conflict, the POs would become platforms representing each art. In contrast to the guilds the POs do not permit compensation for such a conflict, which is certainly frequent in Mediterranean coastal fishing.

(c) The size of the guilds' ports are adequate for the fisherman, who are never out more than 6 hours sailing time away from their base. The POs cover a much greater area (province), there being only 6 producers' organisations, compared to 51 Guilds in the Spanish north-West Mediterranean. Real control among the fishermen is much more effective if the regulated area is of similar size to the work area of those who regulate themselves.

(d) The guilds control and manage the markets where the produce is sold. The POs should alter or set up new commercial stages in order to centralise the existing landing system in fresh fish ports within their provincial jurisdiction). This would affect the quality of the produce and the systems of work.

In the meantime, any possible problems have been avoided by matching the spirit to the law; officially, coastal fishing is carried out within the Community frameworks, but in practice is it the guild frameworks which are adhered to. The fact that this has not resulted in conflict is linked to the fact that Mediterranean coastal fishermen can obtain a much higher price on the market than the guaranteed price. Therefore the POs have lost one of their basic functions: to control the guaranteed prices established by the EC.

The effect of the EC norms has been to create fictitious institutions so that the real situation could be fitted into frameworks worked out by Community bodies. But the problem is not only official. This fiction which has so far proved to be innocuous, has opened up the possibility of deregulating the coastal fishing sector. However the cost and consequences of this situation have not yet been estimated.

4. The Specific Case of North-Western Mediterranean Fishing: Coastal Fishing

Whatever changes are made in the organanization of the fishing sector, they must take into account the implications that stem from effective resource control. Experience shows, that in the region under observation, effective economic surveillance is in the hands of the guilds i.e. the fishermen. A group of administrative regulations exist which has little chance of being put into practice because the fishermen have refused to accept them. On the other hand, once the fishermen, through their guild, establish a norm (timetable, nets, and so on etc), it is followed very strictly, even though it has not been legally established.

The guilds have to hand very powerful self-regulation mechanisms, in the respect that they have a massive potential which is far more effective economically in controlling the home market than administrative sanctions. This has its advantages and disadvantages. The main advantage is obvious, the low cost and the effectiveness of a surveillance system. The disadvantages stem from the fact that the administration is forced to convince the sector of some of its measures, which can at times delay or limit its capacity for action. Within this context, whatever the control system used, it must be a compromise. The administration can look for methods of control by using political-administrative measures which will not be laughed at by the fishing sector (the price of fuel, permission to moor boats in ports, aid, etc.) but at the same time, it does not make economic sense to reject a control system which, in spite of its limitations, is very cheap, and which has managed to maintain a satisfactory equilibrium.

It should also be noted that in the Spanish fishing grounds controlled by the guilds, overfishing and overinvestment have never caused a breakdown of the operations, whereas this has happened in certain deep-sea fishing grounds which have not been controlled by the guilds.

It is necessary at this stage to emphasize that the poor efficiency of administrative surveillance can be explained by the inadequate level of funds given to this sector. Once beyond the guidelines directly established by the guilds, surveillance seems to be ineffective and very costly. For this reason it may be dangerous to reduce the true capacity of the guilds, by applying to the letter the formulas used by the EC in the Atlantic (producers' organisations). The truth is that these days, effective surveillance in the Mediterranean is in the hands of the guilds (or with similar organisations in France and Italy). Given this risk, one must consider what price one would be prepared to pay in order to change the traditional system of control. That is why it would be interesting to recall what the net income from fishing is: 2,935 million pesetas in 1989 within Catalonia.

If we consider that in order to be certain of adequate surveillance of this zone, at a minimum it requires some 15 patrols, with 75 crews, a body of land based inspectors that will include the 29 fish markets, then even with very low estimates, we are already talking about an initial investment on boats of between 1.000 and 1.200 millions and an annual cost of between approximately 300-500 million pesetas, all of this in order to obtain a result which is probably inferior to that already obtained by the guilds.

So the question is: does it make sense to increase the administration's expenses with respect to surveillance groups?.

In our view, a rational solution to the problem would be restrict the expansion of the forces, in order to avord the over dimensionalisation of the over financed sector. However, once administrative incentives for over-investment have ceased, the priority should be to limit the regulations as little as possible and to allow the Guilds, under strict supervision by the administration, to adapt their efforts to their environment.

One potential problem, is the following:

- If the fishing sector should directly confront the consequences of joining the European Community, in a process which undoubtedly brings with it irregularities and unpredicted tension;
- If excessive investment would lead to a policy to reduce the European fleet by 40%.
- If up until now the administration has been incapable of effectively controlling the fishing sector;
- If it is implausible to think about a substantial increase in surveillance, because in net income, the fishing sector now receives more money than it generates;
- If this at the same time leads to an associative structure, which among other thing, duplicates the functions of self-regulation.

Then there is obviously a clear risk in ending traditional self-regulation systems, by legally dismantaling the guilds, and substituting new regulatory systems, when the new producers' organizations lack the social basis necessary to impose their regulation.

The danger of this situation is the fact that, legally, the self-regulation of the exploitation of the present fishing resource is assigned to two fishing associations. If it is clear that a duplication of this kind is impossible to maintain without causing conflicts in the short term, for example, in the face of a rigorous administrative reduction of effort, one must begin to evaluate how to overcome this duplication; that is to say, what ought to be taken away in order to define clearly, who, among the fishermen, is responsible for the management of the natural resources.

The system, which now has its own control mechanism, can undo its own structure by witholding authorisation of some of the guilds' basic responsibilities. The sad thing is about this situation would be about this is that only under these circumstances would the authorities give warning of their unwillingness to pay for a new, effective surveillance system because of its high cost.

The administration (at all levels — from Community to regional) should be extremely careful not to destroy management methods that have, proved their worth within the highly complicated framework of coastal fishing. On the other hand, it does not seem to be the best moment to introduce ambiguity into the traditional system of self-regulation, when it is on the point of an important reconversion which is aimed at reducing the forces.

Before trying to apply uniform models (at the EC level), to operations that are very different from those being analysed, it is important to consider the possible consequences of such an action, and also to consider using something that already exists (guilds) for the type of management that the administration proposed.

5. Some recommendations about the future common fishing policy of mediterranean fishing

Traditionally the guilds which have regulated coastal fishing and the conflicts that occur in the Spanish North-West Mediterranean. These conflicts arise because of an activity which exploits a freely accessible, renewable natural resource. In practice, the guilds have come to occupy the role of quasi proprietor in this situation, acting as a collective, rationalising proprietor of a freely accessible and renewable resource.

In order to fulfil this role, the guilds have supplied a series of mechanisms (timetable control, supervision of the art of fishing, size control) which have been perfected by everyday practice. This allows the objective of the rational use of resources to be fullfilled at the lowest possible cost. The guilds have often applied regulating measures in their zones which are much stricter than those legally established by the administration. The mere fact that it has survived historically should be enough to draw one's attention.

The peculiarity of coastal fishing is not based on the subjective will for survival of certain institutions but rather on the objective diversity of the species and the proceeds of capture, the relatively small scale of these captures, and the need to resort to small-scale methods of fishing. All this creates an enviroment in which the models of work based on a certain level of business concentration are not viable. This is characteristic of fishing grounds such as the Atlantic which generate a product of quantitative importance but qualitatively of limited diversification. It is not possible to alter this enviroment, at least not with the presently available techonolgy.

Given this situation, it could prove to be both costly and inefficient to introduce management methods that have been established legally in other parts of the EC. It is not the right moment to force the administration to convert its legal powers of surveillance and control into purely fictional operations, when in fact these have developed from the guilds, because the truth is, that the situation in the Mediterranean is quite different from that in the Atlantic whare the EC Common Fisheries Policy has been developed. There are many more managers and types of activity and there is much more decentralization of production.

This does not mean that the administration should relinquish its control, or that it should leave the management of political fishing grounds exclusively to the Guilds. The administration will continue to concede certain aspects of control to the fishing associations, prefering to manage directly those measures that it can adopt efficiently and simply-subsidies, the cost of fuel, the quality control of the markets, operation permits, capacity control, etc.

It is useless to imagine for example, that the administration should control the timetable of every port, because it would be counterproductive to have civil servants enforcing rules when the fishermen effectively enforce these very same rules at zero cost. Even more counterproductive would be to have civile servants trying to regularise the force by establishing reduced timetables while maintaining investment subsidies and fuel. This would only imply an increase in public spending with no result. It is clear that the potential return in no way justifies such an expense and that the traditional systems of self-regulation can work at a very low cost, as long as it is clearly indicated who is in charge.

Faced with such a situation, it is worthwhile economic asking which economic policies can the EC establish to improve the situation. An important aspect of this question is the need to facilitate an agreement between the different levels of the administration regional government member states and the EC, in relation to the specific policy of the Mediterranean coastal fishing grounds. Without a basic agreement on the fundamental issues, it is going to be even more difficult to avoid contradictions and the co-operative use by some groups of fishermen of certain aspects of the regulations against others. Some of the possible elements necessary to form the basis of this fundamental agreement could include the following:

The first step should be to establish a differential management regime for Mediterranean coastal fishing, separating it from that which has evolved for the Atlantic fishing grounds[8]

This implies a concerted effort by all parties:

(a) First *the EEC should abandon uniformity*, because the true situation is not like this. The fact that they are all fishermen does not mean that the productive, biological, technological and organisational frameworks are alike. It is clearly an effort for the EC to renounce the uniformity in the associative structure of the fishing sector, but it ought to realise that it is not dealing with peculiarities derived from state frameworks, but with different forms of production associated with diverse geographical frameworks. The associative unification ought to be based on the uniformity of the whole of the Mediterranean community and coastal fishing, which has the same peculiarity (or dissimilarity from the Atlantic) in the French, Italian or Greek Mediterranean.

(b) The member states should stop forcing the extension of Community measures directed towards the Atlantic with the aim of maximising the level of aid obtained. Both Spain and France should divide their fishing activities, which would require a geographical differentiation between the Atlantic and the Mediterranean. Moreover, regional governments with jurisdiction in the region of Mediterranean coastal fishing should establish a relationship between their own states and the EC, by looking for a common policy for the areas which practice coastal fishing, and should give up trying to compare their grievances with those experience in the Atlantic fishing grounds.

After this principal agreement, the second stage could be seen as the development of a fishing policy being designed to suit the needs and potential of Mediterranean coastal fishing: policies that can be directed not only to the rational development or its potential with regard to self-regulation but used to improving the quality and commercialisation of the operation, abandoning worn out policies directed towards developing the fishing effort in the obviously limited grounds of the Mediterranean.

In practice, this differential treatment means rejecting the implantation policy being enforced by the producers' organisations and fitting into the Community plan, and other countries corresponding organisations such as the Proudhomeries (France), Co-operatives (Italy) etc., making norms and names uniform if this so desired, but maintaining the commun organisational form of these institutionsi.e management of all fishing resources based on a specific geographical area of the fishing coast, strictly outlining management areas within the work zone and the comercialisation of each fishing community, active participation by all fishermen (owners and employees) in the democratic management of their associations, etc.

The coming into force of the norm which regulates the Community fishing policy implies a reduction in the powers of the state and of regional governments. This is nothing more than the firm application of a basic Community principle which makes possible the ideal of a united Europe. However, one should not conclude that Community norms can be established with uniformity ans still be compatible with the different truths that shape the different parts of this Community.

After an exhaustive study of the fishing industry in the North-West Spanish Mediterranean, and considering the situation of Spanish coastal fishing in the rest of the Mediterranean, we contend that the difficulties in adopting determined associative forms do not stem from supposed national differences (the longest tradition of the Spanish fishing sector), but rather from structural differences

[8] R. Lostado, 1991, *Anàlisi econòmica del sector productiu pesca al Pais Valencia en el marc de la adhesió d'Espanya a la CEE,* Thesis Doctoral, Universitat Autonomaa de Barcelona, Vol. I, cap. V, pag. 140-153.

in fishing operations (between the Atlantic and the Mediterranean, between coastal fishing and deep-sea fishing) which should treated differently by Community law.

These difficulties and conflicts stem from the fact that we are dealing with different types of fish rather than with different countries. The solution probably lies in establishing different legal frameworks for each type of fish, with one framework for each country. The potential loss of uniformity would be compensated for by a greater realism in the legal aspects of the subject and consequently by more efficient Community policies.

Section 3

Coastal Management

The Deterioration of the Environment, Flexibility of Reaction, and Rent: The Case of a Lagoon Area

by

MICHEL GARRABÉ and MARIE-HÉLÈNE DABAT
Centre d'Etudes des Projects (CEP), Montpelier, France

1. Introduction

The object of this study is to examine the integration of recognition of the increasing environmental risks into shellfish-breeding activities in the Thau Lagoon in Languedoc-Rousillon and the consequences of the deterioration of the environment in terms of variations in the financial income and the rent of these producers, defining 'rent' as payment made to a means of mproduction over and above its opportunity cost. TheThau lagoon is a salt-water lagoon of 7,500 hectares, 19.5 km long with a capacity of 300m̃3 It is the second largest lagoon in France, with 700 shellfish farms and 850 concessions (1987). Its production in 1987 was 17,000 tonnes of oysters and 8,000 tonnes of mussels, with a n added value for the complete production line of *163,000 million* francs.

This report follows three previous ones by the Centre d'Etudes de Projets which were:

1. A report on the flexibility in fisheries activities (Garrabé, Dabat and Rey, 1990) for the second European Association of Fisheries Economists meeting dealing with distinctive features in the capacity and adaptability of aquatic farmers in relation to the changes in their environment. (Garrabe, Dabat and Rey, 1990). Examples taken from the four sub-divisions of traditional aquaculture, the new aquaculture, non-industrial fishing, trawler and tuna fishing allow us to observe the mechanisms of emergence and of inhibition of flexibility in production units.

2. A report on systems of shellfish-breeding exploitation's in the Thau Lagoon (Garrabé, Daures, Antona and Rey, 1988), which shows how the existence of secondary activities by the shellfish breeder or of outside family income can lead to specific strategies in marine cultivation. The analysis is done on the basis of an investigation of shellfish-breeding in the Thau lagoon which allows for the setting up of typology of firms with different strategies concerning parameters of size and reproduction.

3. A publication on the evaluation of the effects of an event damaging the Thau Lagoon (Garrabe, 1990), describing the emergence, during the summer of 1987, of a lagoon pollution of the "malaigue" type in the Thau Lagoon which resulted in direct and indirect losses. The object of the study is to propose an evaluation of the measurable costs by using various successive approaches, as will as identifying the costs which cannot be counted.

This study will include three specific ecological risks: dynophyisis, the "malaigue" and salmonella. The first two risks appear locally in a recurrent fashion, whereas the last has appeared only once on the Mediterranean coast. The first risk concerns the Thau producers indirectly, whereas the last two have directly concerned the lagoon production.

2. Risks and Production

2.1 — *The operational typology of risks*

The functioning of an activity in a given environment is susceptible to four types of risk (Favereau, 1989):

(i) external recurrent risk.

(ii) external non-recurrent risk.

(iii) internal recurrent risk.

(iv) internal non-recurrent risk.

The first concerns a type of normal risk such as the fluctuation of prices or market variables or even a frequent risk such as a bacteriological accident. The second represents an exceptional risk, not necessarily a major one, but of rather less interest; as in the previous case, the producer has no control over this risk. The third concerns a type of risk which the environment must support due to the activity, but which, because of the insertion of the one in the other, affects it directly and continually. The last type of risk has the same characteristics as the preceding one except that it is non-repetitive. The classes of risks proposed can be combined in certain cases and may lead to irreversible conditions. They determine, however, specific flexibilities of reactions.

2.2 — *A recurrent internal-external risk: the "malaigue"*

This is a phenomenon which chronically affects the lagoons of Languedoc-Roussillon. During the "malaigue" which principally comes during calm weather in the summer, the lagoon waters become cloudy and change colour (becoming reddish or whitish, and sometimes brownish), This modification is accompanied by a release of foul-smelling hydrogen sulphide in the water which thus becomes dangerous for most aquatic organisms. This leads to the death of thousands of fish, crustaceans and molluscs. When the winds return, the waters clear and the biological cycles recommence. Such dystrophic crises occured in the Thau Lagoon in 1975, 1982, 1983 and 1987. The shellfish production lost due to the malaige in 1987 was estimated to be between 19 and 43 million francs (at 1987 prices) according to the sources (Affaires Maritimes Conchyliculteurs, Centre D' Etudes de Projects).

2.3 — *A non-recurrent external risk: salmonella*

Salmonella is a bacteria capable of rendering oysters and other shellfish toxic but which does not lead to any mortality in the biomass, unlike the preceeding phenomenon. It gives rise to serious cases of gastro-enteritis in consumers of infected shellfish and can sometimes be deadly. The prohibition on shellfish from the Thau Lagoon for a month and a half (from the beginning of December 1989 to mid-January 1990) because of salmonella resulted in a serious economic setback for the local shellfish-breeding industry, to the sum of 56 million francs in 1990, corresponding to 4500 t of oysters and 1000 t of mussels because the producers generally sell a high percentage of their oysters during the Christmas season. This value is probably overestimated because there is no production loss, although there is a delay in sales. These effects certainly exist, though without a direct relationship with the quoted figures.

2.4 — *A recurrent external risk: dynophysis*

This phytoplanktonic organism, composed of unicellular algae, secretes a diarrhoetic toxin known as the DSP toxin, which can be dangerous for the consumer when there is a certain concentration in the mollusca (a gasto-intestinal type of toxicity). The infestation period is usually from April to September, and the vehicles of disease are principally mussels and certain other shellfish (filtering molluscs): pullet shells, sunset shells, and olive shells, Oyster, sea urchins and violet shells do not become toxic (there is only slight contamination). Dynophysis does not develop in lagoons since the biological conditions are very different from those of the sea.

2.5 — *Causative factors of occurrence of the risks*

Malaigue

The factors leading to the malaigue are essentially climatic: very hot weather, an absence of wind for several days making the water stagnant, the presence of a slight north wind, which is favourable to the upwelling of deep water, and a very sunny period all explain the triggering and the propagation of the dystrophic process between June and September.

However, the underlying causes of the analogue are the accumulation of organic matter in the lagoon: natural bio-deposition, the natural macrophytic development of the border zones, shellfish bio-deposition, (20 tonnes of dry waste per trestle per year or 400 kg per m̂3), the waste from detachment of oysters at harvest (estimated annual production for the lagoon reaches 10,000 tonnes of waste for 20,000 tonnes of shellfish produced (CEPRALMAR < 1988) giving about 9,000-13,000 tonnes of waste annually (Hamon, 1991)), urban, agricultural and industrial effluents, and the recent development of the Sargasso alga.

The type of management favoured by the breeders seems to play a role in the accumulation of organic matter: an increase in the density of shellfish stocking increases the bio-deposition in

proportion, and the decrease in light penetration due to this increase in density limits even more the consumption of hydrogen sulphide.. The absence of controls for waste deposition of organisms on the breeding structures is another aggravating factor.

Salmonella

The sources of pollution which can have an effect on the development of salmonella in the Thau Lagoon are: the overflow of used water in the municipalities of Bouzigues and Marseillan (bordering the lagoon) which happens regularly during heavy rain; the illegal dumping lots in the countryside behind the sea which pollute the underground springs; the lagoon-filtering station at Meze which discharges salmonella into the lagoon; The sewage disposal station of Mourre Blanc, which is badly equipped with sanitary equipment; the water purification stations in the municipalities of Pinet and Pomerols which are contaminated by waste from the wine co-operatives; and two areas of the town of Sete with 6000 inhabitatants) which are not connected to the purifying station, according to a report by P. Deltour, DDASS. These different sources of pollution do not account for the same level of pollution nor the same frequency of contamination. The overflow of waste water is limited to periods of heavy rain, and the pollution from the wine co-operatives occurs only at a certain period of the year. All these factors certainly converged in November and December 1989.

2.6 — *Classification of the causes of risk*

The causes of malaigue and salmonella are attributable to three factors: natural factors, factors related specifically to the shellfish-breeding activity, and factors external to shellfish breeding. The following table proposes a classification of the causes of risks.

TABLE 1

Causes of Risk

Types of Causes	Causes	Risk
Natural Factors	— Natural bio-deposition	Malaigue
	— Natural macrophytic development in the border zones	Malaigueu
	— The recent development of the Sargasso alga	Malagiue
Internal shellfish — breeding activity factors	— Shellfish breeding bio-deposition	Malaigue
	— Oyster detaching waste	Malaigue
	— Insufficient cleaning of waste deposts on the structures	Malaigue
	— Bad sanitary equipment at Mourre Blanc	Salmonella
Factors external to shellfish breeding	— Urban, agricultural and industrial effluents	Salmonella
	— The overflow of waste water	Salmonella
	— Forbidden dumping lots in the country behind the sea	Salmonella
	— The lagoon filtering station at Meze	Salmonella
	— Wine co-operative wastes	Salmonella
	— Areas of Sete not connected to the water treatment station	Salmonella

F

The ecological risks presented by the Malaigue, Salmonella and Dynophsis seem to be increasingly important.

An investigation conducted among the producers (CEPRALMAR) tends to show that the cases of malaigue are no more numerous than in the past, but those observed during the last few years have become larger in scale (more extensive damage, larger areas being affects). Before the beginning of the 1970's the malaigue occurred essentially in bordering zones, with its extension limited in size (a few hectares) as well as in time (a few days a week). It was exceedingly rare that the same zone would be affected several times in a season. A natural phenomenon, the malaigue was even considered to be an advantage, leading to purification of the environment and more plentiful fishing. Beginning in 1970-71, the cases of malaigue became larger in size, not being limited to the edges of the lagoon, and having the tendency to persist for a long time. In 1975, the shellfish mortality attained 100% of the stock in the deep part of the shellfish zone A in the east of the basin. In July 1982, 200 tables in zone 'B' were completely polluted and even more in November of the same year. In July 1987, the malaigue extended into zones 'B' and 'C', avoiding only the zones further out and ruining 10.5 tonnes of shellfish (Affaires Maritimes).

The absence of recurrence in Salmonella prevents one from assuming any increase in its risk of occurrence. The reinforcement of controls by scientific authorities heightens the probability of detection of this bacteria. According to professional workers, no gastro-enteritis occured in 1989 (it had been particularly numerous in 1987), but consumers expect the risk to increase.

Cases of the concentration of dynophis in sea mussels are becoming more and more frequent on the Mediterranean coast.

3. Reactions and Flexibility

3.1 *Types of identified reactions*

Certain activities of shellfish breeders have the effect of increasing the biomass in suspension in the Thau lagoon (essentially the first three of the following):

1. A tendency to resoak the sea mussels in the lagoon. The producers tend to resoak the mussels, either to avoid dynophysis (the transfer at the beginning of the summer of contaminated shellfish to dynophysis-free water for the required one month's decontamination; — the risk of contaminating a healthy sector of the lagoon by such transfers being minimal), or because all the mussels which has been detached and prepared out of water have not reached a commercial size (these soakings are done all year round and enable the producers to avoid the cost of returning small mussels to the lines as well as to dispose of nearby stock). Regarding dynophysis, whereas a resoaking of 30 days was sufficient in 1987, as well as for those from the beginning of June to the end of July; where six weeks of decontamination were necessary.
2. A growing tendency to keep shellfish on the trestles all the year round. Until 1982 or 19983, it could be estimated that the oyster-breeding biomass was close to the annual commercial production. The oysters were laid for breeding in February or March and sold mainly during the Christmas season. In the meantime profitability was sustained by mussel sales. As mussels are being more and more replaced by oysters, the producers in order to guarantee a profit are now obliged to raise and sell oysters all the year round. Thus, from 1980 to 1896, the oyster-breeding biomass was almost zero in January and February, and reached 35,000 tonnes in November and December. In 1987 and after the observations of 1988, it appeared that the lagoon supported a biomass approaching 25,000 tonnes during the whole year.
3. The breeding of large mussels. More and more farmers are allocating large mussels (4 cm. half-size) to the breeding stock. They spend only part of the year in the lagoonand are immediately replaced after sale. It is therefore possible to have two or three rotations in a year and the tables are almost permanently full. This method, however, has only limited impact because of the reduction in the overall number of mussels in the lagoon.
4. Irresponsible attitudes towards the lagoon. The shellfish farmers, in spite of some improvements, still retain irresponsible attitudes, which are harmful to the environment, detrimental for the growth of shellfish and liable to increase the risks of maligue and salmonella: these include jettisoning of waste from the detaching process back into the lagoon or near it, the inadequate cleaning of the waste deposits on the structures, non-collection of waste deposits accumulated under the tables, and insufficient sanitary equipment in certain farmhouses.

3.2 *Types of Corresponding flexibility*

The resoaking of the mussels from the lines in the lagoon and the increase of the rotation of stock of mussels and oysters indicate a certain flexibility in production units (Garrabe *et al.* 1990), as indicated by the following flexibilities:

1. External (or decisional) flexibility of initiative: in the case of resoaking the sea mussels in the lagoon vis à vis dynophysis: an attitude of strategic inclusion of the information received with regard to modification called for by the external environment.
2. Internal (or productive) technical flexibility: in the case of the reimmersion of the sea mussels in the lagoon and dynophysis and fallback in the lagoon) this flexibility measures the space of the production in the choice of process as well as in their internal development.
3. Internal (or productive) organisation flexibility; in the case of the modification of the producers' strategy: the capacity for external development in the production-distribution process which is exercised under technical constraints.

The shellfish farmers' approach to exploitation of the resoource, however, is marked by an absence of flexibility.

4. Rent, Production Cycles, and the overloading of the lagoon: the T box

The identification of reactions in the face of risk can lead to a certain number of short term and medium term consequences:

4.1 *Overloading and production cycles*

In the short term, the main consequence is apparently (1) an excessive increase in the biomass of the tables in the lagoon, which results in a longer maturation cycle for the shellfish, and (2) it is also possible that the mussels could become rarer in the short term in zones B and C, while (3) In the medium term the lengthening of the cycle and the mono-production could lead to vanishing of the weaker rents of the lagoon and the disappearance of the less favoured zones.

4.1.1. *Increase in the loading of the trestles*

It is generally accepted that, in order to obtain a satisfactory growth and size for the shellfish, a trestle should not support more than thousand cords, these being the main feature of a specialised local technique used here for raising mussels Furthermore, from 1980 to 1987, on 70% of the trestles in the lagoon, the number of cords per pole (with 51 poles per trestle) varied form 9 to 14. This number went up to 21 for a minority of very heavily loaded trestles (2-3%), indicating the likelihood of the overloading of some exploitation's which could be harmful to the surrounding trestles. In addition, between 1980 and 1987, the number of trestles rose from 2,058 to 2,548 (2,816 planned) in the lagoon The average number of cords per trestle increased during the same period from 867 to 998.9 (from 841.4 to 1061 for Zone A, from 844 to 894.8 for Zone B, and from 918 to 1,041 from zone C), with zone A having the greatest increase in loading.

4.1.2 *The increase of the biomass in the lagoon*

The increase of the biomass in the Thau lagoon between 1980 and 1987 was clearly shown by the IFREMER scientists who observed an increase of 5,000 T or 14%. The biomass in oysters and mussels was 30,397 t in 1980 (calculated by counting the cords and by sample diving during the tourist period); it rose to 35,501 t in 1986. The figures for 1987 (25,389 t) are not indicative (one single year, a large proportion of mussel broods lost, the year of the malaigue) but it can be assumed that the production has gone from a model of a "growing load" during the year in order in reach a maximum of 350,000 t in November and December, to a lower "model with a constant load" of approximately 25,000 T, but now permanently in the lagoon, since the shellfish farmers now breed during the whole year (a spreading of the load with an increase of the total load per time unit.

4.1.3. *The resoaking of the line mussels in the lagoon*

The estimate of the production of mussels from the lines is problematical (between 50000 and 9000 t for 1990, according to the source). All the licence holders do not give figures, and those who do generally supply incomplete figures. Scientists have difficulty distinguishing mussels from the lines from other mussels, and since flows occur between the sea and the lagoon all year long, it is difficult to follow them.

4.1.4. *The lengthening of the shellfish maturation cycle*

The IFREMER biologist carefully assume that the oyster cycle could now be from 12 to 24 months for glued oysters, compared to the cycle of 12 to 14 months at the beginning of the 1980s. Certain shellfish farmers even speak of a 3-year cycle for the oyster. This long-term lengthening of the cycle however is not demonstrated since it is related to the short-term enrichment of the plankton in the lagoon (the biomass load is not the factor for the lengthening of the cycle, other factors such as sunlight and rainfall also have important effects), e.g., the producers currently report good growth of shellfish (1991).

4.1.5. *Impact of the change in biomass on the environment (Biological limit of the T. box)*

The knowledge acquired concerning the relation between the biomass and the environment (estimation of the number of shellfish in breeding made from the estimated tonnage, and by the quantity of filtered water and this indirectly of the ingestion of nourishing particles) and the theoretical work done by IFREMER on the parameters of the Thau lagoon, tend to indicate that the lagoon has a sufficient trophic capacity to assure a steady growth of shellfish (the equivalent of the total capacity of the lagoon was filtered in 2.81 days in 1986, and the quantities of plankton taken off by the shellfish were reconstituted in 24 hours). However, the quantities of plankton consumed by the shellfish were replaced in 24 hours). However, the quantities of plankton were calculated as if the mollusca were spread out over the 7500 hectares of the lagoon. In addition, only breeding molluscs were taken into consideration, whereas rivals such as the ascidian (tunicate — large quantities during certain parts of the year) and the various other naturally occuring organisms also exploit the plankton.

4.2. *Flexibility and Rent*

Two significant types of rent are generally distinguished by whether they use non-renewable resources or renewable resources with an excessive depletion; Malthusian rent and Ricardian rent. Malthusian rent measures the advantages of present opportunities for the users who now have a resource whereas Ricardian rent measures the advantages of disposing at the beginning of exploitation conditions with growing incomes.

In the case of the Thau Lagoon, reserves in nutrients, even though variable, would be stable for the short-term. In contrast, the biological mass in suspension increases, and thus the annual exploitation production decreases. This is the opposite situation to that pertaining in agriculture where the fall of fertility is stopped by an increase in entrants, which diminishes production and where production per unit period is maintained by increasing the costs of production. In shellfish farming in the Thau Lagoon, periodicity cannot be maintained (it would be necessary to spread the nutrients, which would transform the traditional aquaculture into intensive aquaculture); on the contrary the annual coasts are maintained but with a decrease of annual production because of lower production corresponding to these costs. This means that for the same quantity of production the annual cost rises.

The rent we are discussing here is the Ricardian rent. This model is appreciated in time and space. In the Thau Lagoon, there are differentiated three geographical zones (A,B, and C) and seven productivity zones,

General Representation

Figure 1

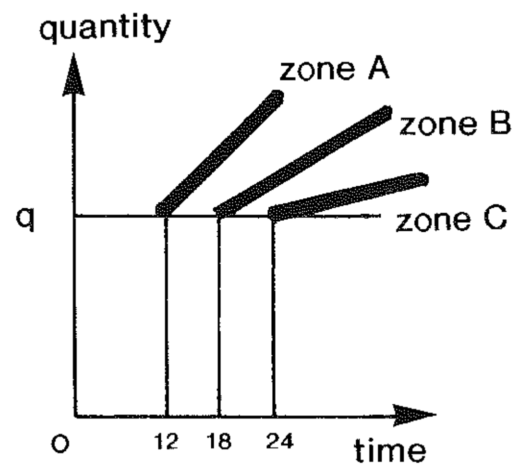
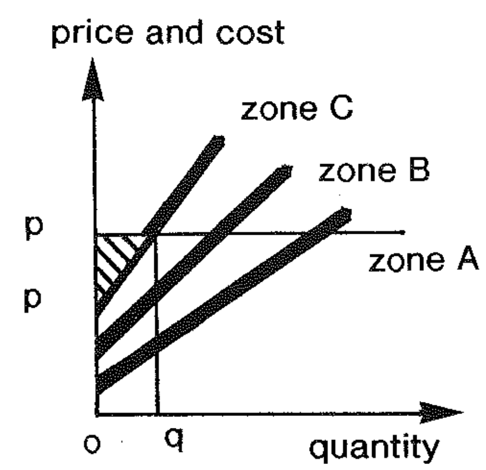


Figure 2



In space, the rent can be measured: the rent from zone C (the least favourable) is probably near zero for many exploitation's. In this zone, secondary activities express (and mask) the reality of condition, from the profitability. The rent of C is lost when the price falls from p to p. For a price p, the rents from the zones are graded.

Thus for quantity Q, given for each of the zones, the respective rents are:

$$R(A) = op \times oq - \int_o^q cm_A(q)\,dq$$

$$R(B) = op \times oq - \int_o^q cm_B(q)\,dq$$

$$R(C) = op \times oq - \int_o^q cm_C(q)\,dq$$

Hence:

$$R(A) > R(B) > R(C)$$

If

$$\int_o^q cm_C(q)dq \; > \; \int_o^q cm_B(q)dq \; > \; \int_o^q cm_A(q)dq$$

*The lengthening of the production cycle

We introduce the variable income (R), mussel-broods (or half mussels or oyster) (N), production costs (CP), as well as the result (RBE).

– With a 2-year cycle

$$R_t = N_{t-2} + \sum_{t=-2}^{t=0} CP_t + RBE_t$$

$$R_t - RBE_t = N_{t-2} + \sum_{t=-2}^{t=0} CP_t$$

– With a 3-year cycle

$$R_t - RBE_t = N_{t-3} + \sum_{t=-3}^{t=0} CP_t$$

cost of the lengthening of the cycle:

$$\boxed{K = (N_{t-3} + \sum_{t=-3}^{t=0} CP_t) - (N_{t-2} + \sum_{t=-3}^{t=0} CP_t)}$$

*Lengthening of the cycle with reproduction expenses (DR)

– With a 2-year cycle

$$RNE^{2}_{t} = R^{2}_{t} - \left[N_{t-2} + \sum_{t=-2}^{t=0} CP^{2}_{t} \right] - \sum_{t=-2}^{t=0} DR^{2}_{t}$$

– With a 3-year cycle

$$RNE^{3}_{t} = R^{3}_{t} - \left[N_{t-3} + \sum_{t=-3}^{t=0} CP^{3}_{t} \right] - \sum_{t=-3}^{t=0} DR^{3}_{t}$$

Rent for a single exploitation before the lengthening of the production cycle

$$\triangle \text{ Rente} = RN^{2}_{t} - RN^{3}_{t}$$

*Lengthening of production cycles with expenditures of reproduction and the increase in the loads of the cords

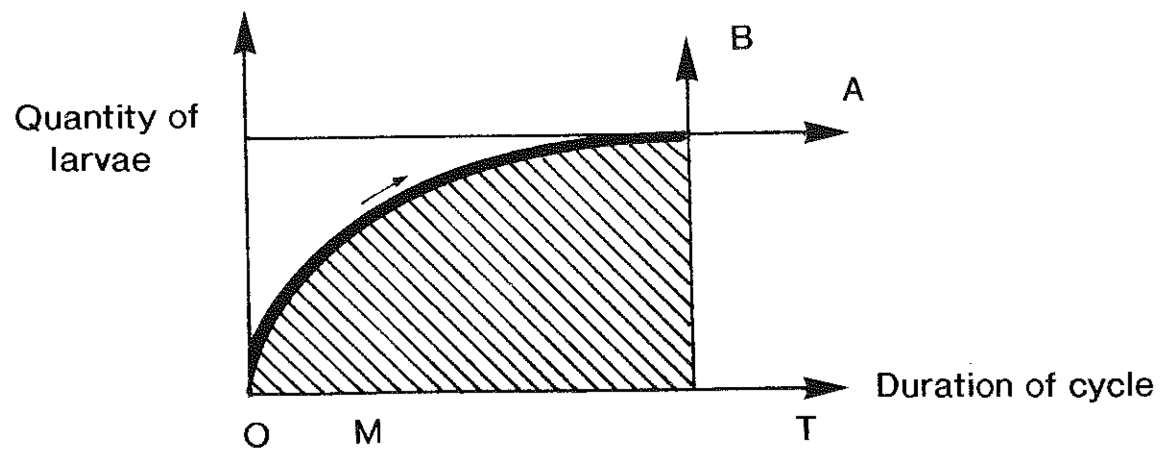
$$\boxed{RNE^{3*}_{t} = R^{3*}_{t} = \left[(1 + a)N_{t-3} - \sum_{t=-3}^{t=0} CP^{3*}_{t} \right] - \sum_{t=-3}^{t=0} DR^{3}_{t}}$$

*the t. box

The observations carried out in the Thau lagoon show that there is a relationship between the initial biological load and the length of the maturation cycle. (In the future the biologists must spell out this relationship). The change of method by the producers, who now exclusively use *half-products*, could result in the lengthening of the traditional cycle, in addition to purely economic considerations., To maintain the length of the production cycle under these new conditions will confirm the growth of production costs.

This relationship between the biological load and the length of the cycle, however, implies two limits, one biological, the other economic:

Figure 3



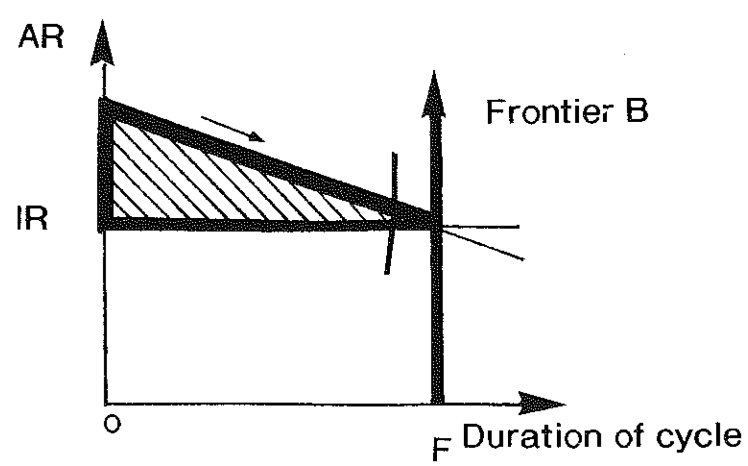
Limit A represents the biological limit for the quantity of shellfish in the lagoon, considering their nutritional needs and other biological and economic constraints.

Limit B representss the economical limits of the length of the production cycle, This is a limit beyond which the farmers would partially or totally abandon their shellfish breeding activities.

Two types of flexibility can correspond to this limit.

A flexibility for a large exploitation (zone A):

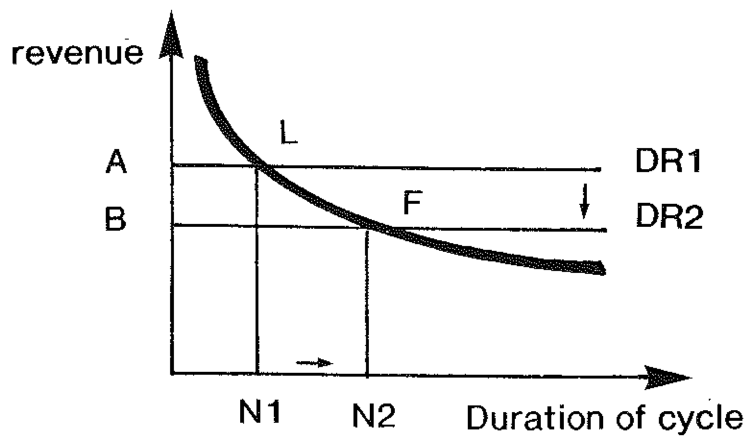
Figure 4



The lengthening of the cycle will result in a decrease of the annual TRI by one marginal unit of investment. The economic limit marking the maximum length of the production cycle appears when the rate of profitability of opportunity balances the falling TRI. The expected net rent is in the filled-in area.

A flexibility specifically for smaller exploitations (Zone C)

Figure 5



The annual income decreases when the productive cycle lengthens, with the result that when the decrease reaches the level DR1, for a time period of N1, the farmer,s stock is not able to cover his breeding requirements and he must partially abandon his exploitation. N1 thus defines the length of the cycle which corresponds to the appearance of secondary activities for a zone and for given exploitation. Secondary activities allow for the placing of the level DR1 and DR2 and thus the acceptance of a new deterioration of his situation (indicated in this case by an increase in the length of the of the exploitation cycle).

5. Consequence and Solutions

Three types of consequences can result from a decrease in the rent: (i) reduction in the number of shellfish farmers in the lagoon, (ii) deterioration of the production zones, with the disappearance of the least productive, and (iii) loss of value added in the local production line.

Reduction in the number of shellfish farmers: This occurs, with a given cycle length, either by the disappearance of large enterprises, having obtained a TRI inferior to the alternative production rate (Figure 4), or by the disappearance of smaller units, where the secondary activities are not sufficient to fill the divergence between the expenses of total reproduction and shellfish income (Figure 5). With a rising cycle length, it occurs due to the aggravation of the previous effects (disappearance of the more resistant units) due to the continual lengthening of the cycle.

Deterioration of zones with disappearance of the poorest ones: Since the enterprises in the Thau Lagoon are not in equally productive zones, we can expect that the present profitability of the most productive tables (zone A, with the most rapid growth rate) could become a profitability of the type of zone B, which would in turn become a zone C type profitability, with the tables the least productive zone in the lagoon (zone C) disappearing because the economic limit in the T. Box has been exceeded.

Loss of the value added in the production line: The decrease in shellfish-breeding activity because of the disappearance of a certain number of producers would have effects on the firms working upstream and downstream in the production sector, particularly at the local level: 163 000 MF of value added (production sector 143,000 upstream sector 17,000 and the downstream sector 3 000) and 875 jobs in the production line in 1986 (Garrabé and Rey, 1987).

Solutions are to be recommended (or are being applied) to clean up the Thau Lagoon in order to limit the ecological risk and to limit the decrease of the rent by restructuring the Thau Lagoon exploitation. These include the Bay Contract, and the Shellfish Breeding Scheme:

Bay Contract ("Contrat de Baie"):
The knowledge and awareness necessary for purification of the lagoon has been realised by the "Contrat de Baie" (1990-1995) of a total cost of 188 MF (principally financed by the EC, the basin agencies, and the local municipalities); its aims are

(i) the improvement of the knowledge of the eco-system of the lagoon: the contribution of the hillside basin, water sediment echanges, exchanges between the sea and the lagoon, and the technological and scientific supervision of the basin,

(ii) the improvement of the quality of the water: the treatment of all the effluents from the communitieson the sloping sides of the basin, the treatment of oyster detachment waste, the channelling of rivers and retaining basins, and the treatment of waste water from industrial firms.

(iii) the modernisation of shellfish-breeding production lines (collective work of the improvement of the shellfish zones and hydraulic work: water taps, input or evacuation piping and the modernisation of the production and loading buildings).

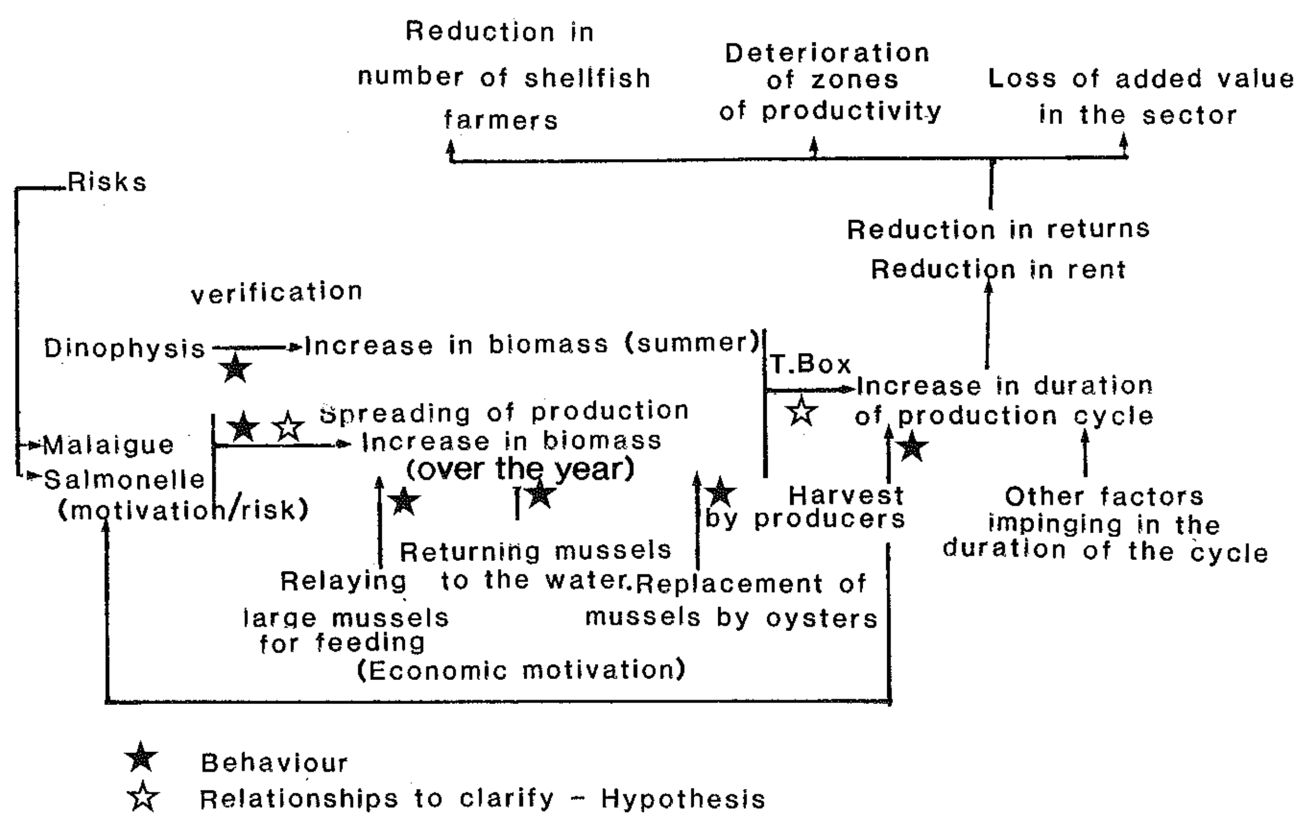
Shellfish breeding scheme ("schema conchylicole")
This scheme, at the present only on the drawing board, aims to reorganise the tables in the Thau Lagoon from a spatial point of view. A different spatial installation, with the installations farther out and the improved spacing of the tables and the cords on the tables, should allow the product to grow more rapidly.

Conclusions

The relations between the economical, biological and ecological parameters considered here and the decrease in rent can be sysnthesized in the scheme illustrated in Figure 6, below:

Figure 6

Relationship between Parameters



Relations are to be as indicated in the previous model:

(i) as the supposed connection between the increase of the risk and the method of spreading of the shellfish breeder's production,

(ii) the interactions between the increase in the loading of the basin and the lengthening of the cycle of the exploitation of shellfish (limit of overloading).

Observations on the shellfish biomass in the Thau lagoon were carried out by IFREMER until 1987 (Hamon and Tournier, *op.cit.*) when they were interrupted. Continuation of the observations on the biomass at the appropriate standard of sampling programme design (sampling system to be random, several measuring during the year), given the modification of the exploitation strategy by the shellfish farmers, is indispensable to the continuation of this analysis.

We emphasise here that the rarefaction of the mussels in the Thau lagoon (mono production) may result in a certain rigidity of the shellfish exploitation.

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Conducting Pan-European Research: A Preliminary Evaluation of a New Methodology for European Aquaculture Research

by

SUSAN A. SHAW
University of Strathclyde, Glasgow, Scotland

and

DENIS BAILLY
IFREMER, Issy-les-Moulineaux, France*

1. Introduction

In 1990 the European Association of Fisheries Economists (EAFE) was asked by the Commission of the European Communities, Directorate XIV Fisheries to carry out *"An Evaluation of the Effectiveness of the Aquaculture Support policies of the Commission with Special Reference to Regulation 4028/86."* This was the first study carried out by the new association and it is appropriate for EAFE to review the procedures and processes which were used as a guideline for future studies. In a wider context, with the enhancement of the role of the European Commission such studies will be increasingly necessary and will require methodologies similar to those adopted on this occasion. This paper may therefore offer some guidelines that will be of general value to those conducting studies in a variety of sectors on an EC-wide basis. First, the main characteristics of the study are described, followed by a description of methodologies. An evaluation of the methodologies follows, together with suggested guidelines for future research of this type.

2. The Study

First, the study required a report on the state of aquaculture by species in the countries of the European Community, with details of current production levels, production systems and business structures and expected future developments. Secondly it involved an evaluation of the effectiveness of both national and European aquaculture support policies by investigation of a sample of recipients of aid and by interviews with industry experts. Finally, on the basis of the findings, recommendations were made for future support policies. The study was formally commissioned in April 1990 and the report containing findings and recommendations was submitted to the Commission at the end of September 1990.

The distinguishing feature of this study was the extensive delegation of parts of the study to researchers in each of the Member States in the Community. The two conveners of the study were responsible for the co-ordination of the study, for aggregation of findings into a single master report and for the provision of recommendations for the future on the basis of collective findings. The two conveners worked as a team (although in separate locations). Responsibility for the provision of a report relating to each Member State was delegated. In total 11 researchers (all EAFE members) from 11 different institutions were responsibility for the various sections of the study. Considerably more researchers were in total involved, working under the direction of the 11 principal researchers.

An alternative method of managing the study would have been the use of a much smaller team of researchers from a single institution, carrying out all parts of the study in the Community themselves. This is probably a more typical approach to project management. Both approaches have advantages and disadvantages. A smaller team with less delegation would have made it possible to use more flexible and less structured approaches. A smaller team, because of its common view of research would probably have collected data which were more easily comparable across countries and certain the costs of project co-ordination would have been much lower. However, a larger team offered the benefit of more detailed individual country knowledge and better local contacts.

*See Appendix for present address.

There are two main reasons why on balance the consortium multi-participant approach was chosen for this study:

(i) Experts based in each Member State could produce a greater depth of analysis within the budget available than would have been possible if fewer researchers had been used because of their core knowledge of each country and the reduction in travelling costs.

(ii) Given the tight deadlines for the study, it would have been very difficult to complete the study on time using fewer researchers.

An additional benefit, although it did not influence choice was that this method provided an opportunity to improve the cohesiveness of EAFE and demonstrate its effectiveness as a European Association.

3. Project Organisation and Methodology

EAFE wished to produce a report that would meet the requirements of the Commission in terms of coverage and quality of analysis, on time and in a cost effective manner. The way in which this was achieved is described as a series of stages: planning, implementation, quality control and delivery.

The data requirements, methodologies and timing of the project were listed and planned by the conveners in early April 1990. It was decided that, with so many participants, the key to success lay in ensuring that data were produced on as consistent a basis as possible across countries and that the same procedures were followed by each researcher. Therefore, a manual was designed which gave data requirements and the methodologies to be used in each Member State. Where it was possible to quantify, the manual contained forms to be completed by each participant. For more qualitative data, a questionnaire approach was adopted. Examples can be seen in Figures 1 and 2. In addition researchers were encouraged to explain with additional text the reasons for their findings.

One major part of the study involved an analysis of a sample of Commission supported projects. It was anticipated that the ease of access of researchers to details on supported projects from Member State authorities would vary. Therefore the Commission gave permission for a team of researchers led by the conveners to extract details of a sample of supported projects from Commission files in order to analyse their characteristics. For a further sub-sample permission was given to attach names to files on a confidential basis. The basis of sampling was a combination of project size, date of support, geographical region and type of project. Unfortunately, details of projects by species were not available so this was not used as a sampling frame. Details were given to researchers in Member States who were then required to report to us on the current status of each of the identified projects within their country.

To give an overall evaluation of the effectiveness of support policies, researchers in each Member State were also required to contact experts within the industry itself, advisers to the industry and government officials, using a structured questionnaire.

Researchers in Member States were not required to produce policy recommendations as a component of the national reports. If they had views on these issues they were encouraged to give them, but in a separate document. Since the Commission required a single consistent set of recommendations it was appropriate for the conveners to provide this themselves on the basis of the aggregate findings across Member States. Researchers were asked to participate in the study during March. The Commission gave an informal go-ahead during early April and research started in May, although we were not in a position to issue formal contracts until June. Researchers were asked to submit country reports to the conveners by 23 July 1990.

The implementation of the project was achieved by:

(i) setting severe cost penalties for failure to deliver a report by the agreed date. It was agreed that no researchers would be paid until EAFE was itself paid by the Commission i.e. the risk bearing was mutual and not that of the conveners alone,

(ii) making sure that as far as possible the conveners were easily and quickly available to answer queries,

(iii) informal and frequent checks by conveners on the progress of each participant.

The project was submitted on time. The completed report comprised a main report of around 50,000 words plus extensive tables. In addition the twelve separate country reports were submitted which gave more detailed findings for each Member State.

In December 1990, having reviewed the report and in discussion with the conveners, the Commission requested additional details and clarification of data from some countries. None of these requirements were substantial or affected major findings and interpretations, although they did involve some extensive and time-consuming searches for supplementary data. A revised report was submitted to the Commission in early January 1991 and this has now been accepted by the Commission.

4. Evaluation of Effectiveness of the Approach

4.1 *Background*

This is a preliminary report based on the experiences of the conveners and from that viewpoint is somewhat limited. The views of other participants are being sought as are those of the Commission and these will be incorporated in a subsequent version of this paper. In general, the conveners consider that the report met its objectives since it was acceptable to those who commissioned it. At the same time, a number of issues relevant to that success arose during the execution of the study and are considered here. They are discussed under two headings: quantity and quality of available data, organisation of the project.

4.2 *Quantity of Data*

In general most necessary data were obtained. The manual played a major role in this because it had specified requirements in detail. However there were problems in some areas. Areas where particular problems exist are:

(i) *Employment and Numbers of Businesses*

Statistics relating to employment and number of businesses in aquaculture are poor for most Member States. This was a particular problem in Portugal (although major changes are now believed to be underway here), Italy and Germany. There were variations by sector within countries (e.g. good finfish data but poor shellfish data in the UK). As a consequence statistics available are considered to be a considerable underestimate of actual numbers of employees and businesses (Figure 3) and in some cases may be unreliable.

(ii) *Production*

The identification of species on a common basis across the Community caused problems despite the availability of multi-language manuals for this purpose and especially for minor species. This was primarily because of some use of local names rather than strict adherence to the use of scientific names. The quality of production figures from official sources is variable. Statistics are poor for species with low production levels. This created problems particularly where a species was important in one country (for which data were available) but relatively unimportant in other countries. As a consequence it was difficult to build a European-wide picture of the importance of that species. Examples are of mullet, carp and other fish produced in extensive systems. The report as a consequence underestimates total production levels.

(iii) *Business Structures, Costs and Profitability*

Data on business structures is also limited and in many member states this information is not collected by official sources. Proper surveys of costs and profitability were rarely available, leaving the researchers with almost complete reliance on an engineering approach to the estimation of costs, with all its limitations. Most estimates of costs and profitability were based on application of ex farm prices to production models and are estimates of "average" performance. As a picture of the range of actual costs within an industry they are only an approximation to actual figures. This contrasts with most agriculture sectors and the fisheries sector where more extensive data are available.

(iv) *Response to Surveys*
All researchers followed up individual cases of support and interviewed a sample of industry experts. In general, across all countries the levels of co-operation given were high and all researchers were able to answer the questions posed. This is a helpful finding because without the willingness of members of the industry to provide data good policy making is difficult. Researchers were able to provide representative samples of respondents and experts using the criteria established by the conveners.

(v) *Quality Variations in Secondary Data*
The variations in the quantity of data available from sector to sector were linked to variations in quality. This led to considerable problems in aggregating data for the Community as a whole. Very accurate figures for one country had to be combined with figures for other countries which were often only informed guesses with no real indications of the size of errors around the figure. European data sets combine data of different quality, leading to some considerable caution in using aggregate European data in time series analyses.

4.3 *Organisation of Project: Quality of Material*

Given the time and financial constraints of this study, the conveners were not able to check data submitted systematically. They relied on their own knowledge which between them covered all European countries and some independent evaluations both by members of the Commission and by other experts. This process suggested that on the whole data submitted were the best available, although some anomalies within country reports were identified. The following points are pertinent:

(i) *Time and Aggregation Problems*
There were considerable problems for the conveners in combining the information provided. Although common formats had been requested, data was not always provided in this form. A great deal of time was spend chasing data which from the individual researcher's point of view had been seen as unimportant, but which assumed a much greater level of importance at the aggregate level. The classic example of this can be drawn from attempts to assemble production figures and forecasts. If data for one country was missing for one species for one year, this may rightly be considered by that researcher as not limiting understanding of the development of aquaculture in that country in any way. However, at the aggregate level this makes it impossible to compile a valid total picture for that year. It took about two weeks for a research assistant to compile one table on European production because of the large amount of double checking and "gap" filling that had to be carried out in conjunction with Member State researchers. The same is true of forecasts. Forecasts were requested for 1990, 1992 and 1995. In some cases researchers provided forecasts for different years. Naive extrapolation by the conveners would have been dangerous given the cycle of aquaculture activities. Again considerable checking with researchers was necessary. These are just two examples but this problem occurred in most areas of the study and failure to get it right first time greatly increased the costs of carrying out the study, particularly for the conveners.

(ii) *Comparability of Research*
Wherever they could do so, researchers supplied the data required and answered the questions posed. There was however considerable variation in the quantity of data supplied depending on the attitudes adopted by researchers towards the report. These ranged from researchers who regarded our formal data requirements as a minimum and supplied large quantities of data in addition to this — in some case far more data than either the Commission or the Conveners could reasonably have expected — to those who interpreted our requests as maxima. This applied particularly to requests for policy suggestions from respondents. As indicated earlier we asked for this not to be incorporated into the report but supplied separately. In retrospect this was not sufficiently specific and it would have been preferable to have also organised this section of the study in the form of a questionnaire.

(ii) *The Perceptions of Researchers*
Because of data gaps, the report relies to a considerable extent on the judgements of researchers, particularly for forecasts. The forecasts produced are we hope as valid as those produced by other sources but they leave much to be desired. There are few models available or suitable time series for species so that it is difficult for forecasting to be based on anything other than the judgement of researchers and the judgements of experts consulted. This was a problem for both short and

medium term forecasts. Short term forecasts were probably more reliable for species and countries where accurate information on capacity and stocking plans was known (eg salmon) but was difficult where such information was not readily available (most species in Portugal). All long term forecasts were judgemental.

(iii) *The Perceptions of Respondents*
A related issue arose in respect of the qualitative aspects of this study. By insisting on the use of a standardised questionnaire, we ensured that the same questions were asked in all Member States. A concern however is that respondents in different countries may use different evaluative criteria so that the answers are not really comparable. This can be illustrated by means of the example relating to the views of experts on the effectiveness of government support policies. Experts were asked to judge the effectiveness of national administrations on various dimensions on a scale (1) very efficient to (5) least efficient (Figure 4). All experts answered this question, apparently without difficulty. However, supplementary investigation suggested that "efficiency" may be judged by different criteria in different countries. In countries used to high standards of public administration, "efficiency" may be judged on a different scale to those where public administration in general operates to lower standards of efficiency. We suspect that those most critical of the current system come from countries with well developed systems of public administration with which aquaculture support was compared sometimes unfavourably and vice versa. This problem of the meaning of words is likely to occur in any cross European study with qualitative elements.

4.4 *Organisation of Project: Scheduling*

All Member State reports were received in time to meet the final deadlines imposed by the Commission. Most researchers met the deadlines imposed by the conveners. This was very creditable since due to delays in the formal commissioning of the project, everyone worked without even a portion of payment in advance and in the knowledge that payment might be slow. It is a tribute to the professionalism and goodwill of most researchers that we were able to achieve this. However not all researchers met deadlines, causing major scheduling problems. Some researchers failed to meet deadlines for their reports which in turn complicated the schedules of the conveners and created a crisis for them as far as the production of the main report was concerned. The most severe problem has subsequently been caused by the failure of one researcher to provide supplementary information demanded, although this information was eventually received. It can be argued that one failure out of eleven researchers is not a bad rate. However any failure of this type is serious because it has implications for all researchers and not just the conveners. This delayed acceptance by the Commission of the final report by over two months with consequent problems for all the other researchers.

5. Future Guidelines for Multi-Country European Aquaculture Studies

5.1 *Introduction*

The initial premise of this paper was that the need for studies embracing all Member States within the European community is likely to grow. The experiences described in previous sections have suggested a number of guidelines to be followed in future studies. These are discussed under the following headings: selection of researchers, contracts and timetables and research methodology.

5.2 *Selection of Researchers*

The success of the study was due to the competence of the researchers selected and their commitment to the study, in the face of what were often quite trying conditions. Researchers were selected, in this early stage of the existence of EAFE, largely on the basis of personal knowledge of their work or on the basis of recommendations. It must also be admitted that friendships and goodwill played a considerable role in meeting our objectives and it is perhaps significant (although statistically unproven) that the greatest difficulty was experienced where this link was weakest. We also attempted to select people who had strong motivation for being involved in the study and to complete it successfully. AS EAFE develops, the process of evaluation can become more formal, but similar criteria should still be used:

—past work undertaken and level of responsibility held in previous studies

—record for completing contracts to schedule

—references from contractors

—current commitments and evidence that the researcher has sufficient time to complete work

—evidence of commitment and interest in work

—where relevant indications of support from parent organisation

—sufficient preliminary contact between team leaders and researchers to establish that a viable working relationship is possible.

The nature of the organisation to be selected has not been listed. In this study we used researchers from large organisations and at the other extreme people working largely alone. Contracting with a large organisation helps to reduce risks because it suggests the availability of a pool of researchers, not just the named individual. At the same time, it was not critical in the success of this particular study with the standard of work from individuals often just as good as that coming from larger organisations. The key factor was the competence and the commitment of the individual.

A further key element is the choice of conveners. They must meet the requirements above and in addition where possible have had experience in organising projects involving considerable coordination of activities across a number of countries. It is necessary that they have sufficient knowledge of the topic under investigation on a Europe-wide basis for it to be possible for them to evaluate the data produced by others and in the event of failure, remedy deficiencies themselves. For these reasons, it is likely to be helpful to have two conveners who can between them provide the necessary spread of experience and expertise. Experience with this project suggests that provided that they can contact each other easily and meet reasonably frequently, they need not be based in the same location. As a sine qua non, between them they should be fluent in English and French with at least some competence in German, Italian and Spanish (even if the report is only being produced in English or French).

5.3 *Contracts and Timetables*

In addition to the formal contract between the commissioner of the study and EAFE, sub-contacts should be issued to other researchers by EAFE. These must contain:

—clear specification of responsibilities

—unambiguous deadlines and heavy penalty clauses for failure to produce the appropriate quality of work by the deadlines. While it is helpful and reasonable for researchers to expect some payment at the start of the contract for expenses etc, most money should come on completion of work.

But contracts must be supported by other action. The first requirement is a determination by the conveners to hold participants to deadlines. Obviously, inflexibility has its costs and the conveners have also to be sympathetic to unanticipated problems experienced by researchers. However if conveners do not insist and enforce their terms the project will not succeed. The costs of one default on a multi-participant study are high and conveners must make it very clear that because of this contracts will be enforced.

Timetables require careful planning. In particular, the time for co-ordination and checking when work is received should not be underestimated. It is essential that the gap between the deadlines imposed by the conveners and the deadlines imposed by the project sponsors should be large enough to allow conveners to undertake a proper analysis of data so that they are able to produce sensible recommendations. The recommendations are a key part of any project and failure to allow enough time for this jeopardises the whole exercise. It is tempting to allow longer for fieldwork on the assumption that time can be made up during analysis and forming recommendations but this is an illusion. Secondly, time must allowed for emergencies. The most obvious emergency is the failure of individual participants to produce work or to produce work of the required quality. Early warning of such problems can help here. While it is undesirable to add unnecessarily to the workload, brief interim reports at several stages during the project are necessary. Where possible a meeting of participants should be included in the budget. This is possibly of most value not at the time of commissioning of the project, when researchers have not yet experienced the problems of actually

carrying out the work, but when the work has commenced and feedback on aspects of the study is available. Conveners have a responsibility to keep other researchers informed of current progress on the project, to clarify any issues which emerge and to check informally on progress. This helps to build a common sense of purpose amongst researchers in very different locations and thus to ensure the success of the project. Discussions with those commissioning the study should ensure that everyone has a clear idea of what is involved and that realistic timetables are set in the light of the resources available for the study. A final mundane point but of considerable importance is that all participants have ready access to telephone and telefax facilities. This caused us some difficulties when this was not the case and communications were delayed.

5.4 *Research Methodology*

As far as the environment for research is concerned, European aquaculture research would clearly be more effective were better secondary databases available.

There may be a case for EAFE to act as a pressure group to achieve this.

From the point of view of project organisation, we are convinced of the necessity of providing extremely detailed manuals for study participants in any exercise of this nature. In other studies involving a team of researchers based in a single location who work together throughout the project, ideas are exchanged frequently and informally and to some extent methodologies can be defined as the study proceeds. This is very difficult to achieve with many researchers in different locations. As a consequence, the level of detail to be specified at the start of the study is substantial.

Time spent by conveners in drawing up very explicit documentation at this stage is rewarded by better subsequent information from researchers. In particular the following guidelines are suggested:

—all species should be described using scientific names as listed in the Multilingual Dictionary of Fish and Fish Products(OECD)

—time periods for which data are required should be specified precisely and it should be made clear that researchers MUST adhere to them

—if data are not available to answer a question, reasons must be identified and wherever possible estimates substituted

—all data sources should be specified precisely and the method of collection given (eg 100% survey, 10% sample) and a statement made about the reliability of data

—the sources of all forecasts should be specified and the forecasting method made clear

—researchers should be given explicit questions to answer rather than general guidelines. Conveners must always assume that the manual defines the maximum that they will receive in some cases and for this reason it should be as detailed as possible

—because of different environments in different countries with consequent difficulties in combining qualitative answers across countries, where possible qualitative material should be supported by factual evidence. If this is not possible statements about operating environments should be made by researchers to help conveners to interpret findings

—wherever possible the selection of a sample should not be left to the researcher but supplied by the convener to ensure the selection of comparable data across countries. When following up recipients of EC support the provision of data directly from Commission files is very helpful.

6. Summary and Conclusions

This paper has reviewed some of the issues involved in the management of the first project carried out by the European Association of Fisheries Economists. The project was successfully completed and the Association proved its ability to organise and carry out a complex study. The conveners of the study are very grateful to everyone who participated. In the process we have learned a great deal which will help in the organisation of subsequent projects. A first major finding of the study is of the inadequacy of the secondary database for aquaculture research in Europe. A second finding is of the need in such projects for the provision of very detailed guidelines to be given to researchers, coupled with the implementation of effective deadlines through strong contractual arrangements.

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Figure 1

The Implications of Varying Levels of Delegation in European Research

	Less delegation — smaller team	More delegation — larger team
Methodology	Less structured	More structured
Depth of research	Possibly less — lack of detailed knowledge of each country	More detailed local knowledge
Comparability of data across Member Status	More comparable because of common view of research	Less comparable
Quality of sample sources	Lack of detailed local knowledge may make it more difficult to build good samples	Better local knowledge may lead to better selection
Flexibility	Greater	Less
Costs	Travel costs higher, co-ordination costs lower	Travel costs lower, co-ordination costs higher

Figure 2

EAFE/EC STUDY FORM 2A PRODUCTION, CAPACITY, NUMBER OF PRODUCERS AND NUMBER OF SITES

Species ....

Year	Production (tonnes*)	Capacity (actual/ Planned)	No producers	No sites
Actual				
1983				
1984				
1985				
1986				
1987				
1988				
1989				
Forecast				
1990				
1995				

*Whole live weight equivalent

Figure 3

FORM 4A PRODUCTION SYSTEMS

1. DESCRIPTION

SPECIES ....

Hatchery open system	________
Hatchery closed system	________
On growing intensive off shore	________
on shore	________
cages	________
Semi-intensive	________
Extensive (specify type of system)	________

2. COSTS PER KG

TYPE OF COST ____________________

Eggs/fry/smolts ____________________

Feed ____________________

Labour ____________________

Energy ____________________

Other general expenses ____________________

Depreciation ____________________

Interest ____________________

TOTAL COSTS PER KG ____________________

EX FARM PRICE PER KG ____________________

NET PROFIT/LOSS PER KG ____________________

INTERNAL RATE OF RETURN ____________________

PAYBACK PERIOD (years) ____________________

Assumptions:

food conversion ratio	________
average weight of fish at harvest	________
mortality rate %	________
stocking density (kg cu m)	________
employment full time	________

How have you calculated depreciation?

____

____

How have the costs of operations changed over time?

____

____

How has the structure of these costs changed over time?

____

____

____

3. What data sources have you used?

____

____

4. Comment on the range of error whoch you believe to be associated with the figures above

____

____

Figure 4

European Aquaculture Statistics: Employment, Business Structures

	Employment	Business
Belgium		
France	(recent years only)	
Denmark	(recent years only)	
Germany		
Greece		
Ireland	(recent years only)	n/a
Italy	(recent years, incomplete)	(incomplete)
Netherlands	(incomplete)	(incomplete)
Portugal	Not available	(subject to error)
Spain		
UK	(poor for shellfish sector, subject to error)	(poor for shellfish sector)

Figure 5

9. General opinions on the administration of EC support
(give a value from 1 very efficient to 5 least efficient)

	1	2	3	4	5
Speed of administration					
Ease of application					
Availability of advice and support systems					
Coordination of national bodies and the Commission					
Coordination of regional and national bodies					
Ability of administration to evaluate proposal correctly					
Date requirements					

Aquaculture Development and Coastal Zone Management Strategies: A Comparison of Leading Issues from the UK, Canada and the USA

by

ARTHUR E. NEILAND
Centre for Marine Resource Economics (CEMARE), University of Portsmouth, Portsmouth, UK

and

DAVID E. NOWELL
Department of Geography, University of Portsmouth, Portsmouth, UK

ABSTRACT

Rapid growth of aquaculture in numerous countries has focused attention on wider questions of resource conflicts in the coastal zone. This paper examines the development of aquaculture in the UK, Canada and the USA, countries where the industry is seen as a means of alleviating pressure on wild stocks and of providing employment in marginal regions. Despite the economic significance of aquaculture, however, serious concerns have been expressed over potential adverse environmental and social impacts. The management implications of these impacts are addressed in terms of the differing arrangements for coastal zone management in the three countries. In particular, the paper addresses the question of whether intensification of coastal resource conflicts necessitates a Coastal Zone Management Act, as in the USA, or whether existing institutional structures are adequate for conflict resolution. Recommendations, concerning both future research and future policy, are also discussed.

Key Words:

Aquaculture; Coastal Zone Management; Resource usage conflicts; Conflict resolution; UK (Scotland); USA; Canada.

INTRODUCTION

The management of coastal areas throughout the world is complicated by a wide variety of issues and considerations, not least of these being the difficulties of reconciling economic development and environmental protection objectives. As environmental issues have become firmly established on the political agendas of many countries and as public expectations about preserving the quality of the natural environment have increased, coastal managers have been faced with very difficult resource allocation decisions.

Although concern over coastal management is not new, the recent intensification of some coastal activities have added new environmental and socio-economic dimensions to coastal management. The phenomenal growth of coastal tourism, for instance, has raised questions about the possible detrimental impact of tourism on coastal ecosystems (Miller and Auyong, 1991). The burgeoning aquaculture industry has also added a new sense of urgency to the debate over how coastal management should best proceed. Aquaculture has some obvious advantages, notably the alleviation of pressure on wild stocks and providing employment in remote and marginal economies. Nevertheless, serious concerns have been expressed in many countries over the adverse environmental, economic and social impacts of the industry.

This paper briefly discusses the aquaculture industry in a number of countries and considers aquaculture policy and management as a subset of general coastal and marine policy and management. It is suggested that the growth of aquaculture has focused attention on wider questions of resource conflicts in the coastal zone and on mechanisms that have been developed to resolve these conflicts. The countries considered are the UK, Canada and the USA, nations which share common coastal problems within a similar economic context, and where there is a high level of awareness of the finite and fragile nature of coastal ecosystems. These similarities notwithstanding, the countries exhibit markedly different approaches to coastal management. Comparisons of these approaches should facilitate an evaluation of whether specific coastal legislation (as is found in the USA) is necessary or whether existing arrangements are adequate to resolve conflicts and to promote efficient use of coastal resources.

AQUACULTURE PRODUCTION: STATUS AND PROSPECTS

Levels of aquaculture production in the three countries (UK, Canada and the USA) are summarized in Table 1, based on OECD statistics (OECD, 1989). Aquaculture production in the USA is currently estimated to be around 300,000 t/yr, equivalent to US $500,000, first sale value. This production value represents 18 per cent of the value of total national fisheries production. An estimated 50 per cent of aquaculture production by value (US $250,000) results from the farming of freshwater catfish in the southern part of the country. The catfish farming industry has undergone rapid development in the last decade but now faces problems associated with overproduction and a lack of market development (Barrett, 1990).

Other significant species produced in freshwater are the crayfish and rainbow trout: annual production is estimated to be worth over US $50,000 for each. The remainder of aquaculture production in the USA is made up by salmon and various shellfish, especially oysters. In general, marine farming is limited by a lack of suitable sites and restrictions on development from competing users concerned about externalities such as pollution. Despite such constraints, there are many regions with recognizable potential for aquaculture development, and a key factor here is the continuing expansion of the domestic seafood market. In states such as Hawaii and California, considerable achievements have been made in developing aquaculture policy and new technology, as described by Corbin and Young (1988).

In comparison to the USA, aquaculture production in Canada is significantly smaller. Annual production is currently estimated to be 14,000 tonnes, valued at US $150,000. Over 90 per cent of this production is accounted for by the production of salmonids (trout, Pacific and Atlantic salmon), associated with both freshwater and coastal areas. Aquaculture represents a mere 2 per cent of total Canadian fisheries by value. Although it is generally recognized that the industry has good developmental potential for both finfish and shellfish in coastal areas, expansion of the industry has been relatively slow in comparison to international competitors such as Norway and the UK. A significant factor here is thought to be inadequate support from government in such areas as the provision of infrastructure and financial assistance (Neiland, 1990). However, it is anticipated that governments will address this problem in the near future and expansion of the industry is expected to follow in key areas such as British Columbia on the Pacific coast (Nowell, 1990).

In the case of the UK, and especially for the Scottish regional economy, the development of a significant aquaculture industry in the last decade has been a major success story. Current annual production is estimated to be 50,000 tonnes worth US $400,000. More than 80 per cent of production comes from coastal areas of Western Scotland where Atlantic salmon and shellfish such as mussels are the major species produced, and where the industry has created a significant number of jobs in an area characterized by poor employment opportunities. Freshwater production of trout is also important in southern England. Aquaculture production now represents over 18 per cent of total UK fish landings by value.

Despite the rapid development which has occurred over the last ten years, however, expansion of the UK aquaculture industry, and especially salmon farming, is now subject to certain constraints, and the rate of increase has slowed. A number of important factors may be identified. The general overproduction of salmon worldwide has lowered market prices and reduced profitability causing some farms to close. In addition, the industry now faces various technical problems such as disease control as well as a limited number of suitable sites for further expansion. Most significantly, there now exists widespread public concern over the environmental impact of fish farming which may well result in tighter regulation of future developments and the rationalization of existing ones. A more detailed discussion of current issues in the UK aquaculture industry can be found in Neiland (1991a, 1991b).

TABLE 1

Aquaculture Production in the USA, Canada and the UK (OECD, 1989)

	U.S.A.	CANADA	U.K.
AQUACULTURE PRODUCTION Status Prospectus	• 300,000t/yr (33% marine) = US$ 500,000 (50% marine) 18% Total Fish Landings • Uncertain future (limited sites) • High technology developments • 'Hot spots' eg. Hawaii, California	• 14,000t/yr (90% marine) = US$ 150,000 (90% marine) 2% Total Fish Landings • Good future prospects • Slow development so far • Increasing Government interest Centre(s): British Columbia	• 50,000t/yr (80% marine) = US$ 400,000 (80% marine) 18% Total Fish Landings • Industry hoping to consolidate its recent rapid development • Environmental/Financial constraints • Centre: Scotland
COASTAL ZONE Characteristics	• Very busy coastal zone • Multiple uses, few wilderness areas • 50% national population live on coast and % increasing each year • Marine aquaculture in decline in many areas (pollution)	• Diverse coastal zone eg. British Columbia: 75% pop. live and work close to sea • Importance of traditional resource extraction activities & non-consumptive uses eg. tourism • Aquaculture close to urban centres in British Columbia	• Very busy coastal zone: industrialisation, urbanisation, recreation, waste disposal, fishing, shipping etc. • Aquaculture concentrated in isolated areas of high water quality
RESOURCE USAGE CONFLICTS Aquaculture and other users some major issues	eg. Washington State/Oregon State	eg. British Columbia	eg. Scotland
	COMMERCIAL FISHING eg. Access, Markets RECREATIONAL BOATING eg. Navigation	FORESTRY eg. Logging ENVIRONMENTAL CONSERVATION eg. Pollution, Wildlife, Tourism	
	• Economic, social & environmental impact of aquaculture development? • Cost-benefit analysis of aquaculture development? • Economic efficiency of resource allocation?		
MANAGEMENT OF COASTAL AQUACULTURE DEVELOPMENT Status Major criticisms Evidence of inhibition	• Coastal Zone Management Act (1972) Aquaculture Act (1980) • Role of State Government in management? • Enlightened management in certain states eg. California — good planning & coordination • Over-regulation has inhibited aquaculture	• Complex set of institutional arrangements: Constitution Act • plethora of single resource agencies pursuing individual resource development goals • Complex aquaculture leasing process causing inhibition in aquaculture • Need for Aquaculture Policy/Act	• Plethora of agencies involved in CZ management (especially advisory stages), piecemeal planning lack of national policy • Role of CEC (landlord and regulator)? • System has not hindered aquaculture, regulations be tightened in the future
		CROWN ADMINISTRATION	
SUMMARY	1 Leader in CZM, but reduced Federal Govt. role since 1980 (decentralization) 2 Over-regulation can be a serious problem (aquaculture mis-understood?) 3 Property rights key in the future of aquaculture? 4 Development of consensual resolution of conflicts (Washington State)	1 Even with a vast, sparsely populated coast, conflict seems inevitable 2 Jurisdictional complexity 3 Govt. support and policy needed for aquaculture, location not enough 4 Need for integrated coastal management strategy, present system biased for certain users	1 Vibrant industry can bring benefit to local economy (quantity?) 2 Underregulation also creates problems 3 Information shortage for planning 4 Good industry PR dialogue necessary

COASTAL ZONE CHARACTERISTICS

While it is beyond the scope of this paper to provide a full discussion of the nature of the coastal zones in the three countries, it is important to highlight some of the salient features as a background to the discussion of aquaculture policy.

The attractiveness of the coast for human settlement and the multiple uses occurring in coastal zones have been well documented (see, for example, Coccossis, 1985). The coasts of the USA and the UK, in particular, have experienced significant urbanization and industrialization. It is estimated, for example, that in the USA, well over 50 per cent of the population live on the coast. The majority of the UK's major conurbations are estuary-based. Even in British Columbia in Canada, where population density is lower than in the other study areas, over 75 per cent of the total population of around three million live and work close to the sea.

Traditional coastal industries such as shipping and fishing play important roles in the functioning of all three coastal zones. The British Columbian economy, perhaps to a greater extent than those of the UK and the USA, remains heavily dependent upon coastal resources. In that province, the forest industry which originated in the coastal lowlands around Vancouver, Victoria and Nanaimo, still dominates. The processing sector of the industry remains concentrated in the Strait of Georgia region. The most noticeable manifestation of this is a complex system of log transportation and storage in coastal waters. Alongside such traditional resource extraction activities, however, are non-consumptive uses of a British Columbian coastline which is highly valued for its natural splendour and abundant marine and terrestrial wildlife. Amongst other activities, the thriving marine mammal-watching industry around Vancouver Island is now a significant component of the Province's tourist sector.

Increased pressure on the coastline of the USA have long been recognized. Aldo Leopold (1949, 266-67) wrote:

> "One of the fastest shrinking categories of wilderness is coastlines. Cottages and tourist roads have all but annihilated wild coasts on both oceans. No single kind of wilderness is more intimately interwoven with history and more nearer the point of complete disappearance".

Since then, the coastal zone of the USA has encountered increasing populations and concomitant development pressures. Many of the concerns over this relentless push for development have been documented by Healy and Zinn (1985). An early recognition of the need for increased protection of biophysical resources of the American coastline led to the enactment of the Coastal Zone Management Act in 1972. Although some of the details of this legislation will be discussed later in this paper, it is important to mention at this stage that, if anything, the threats to the USA coastline have increased in magnitude since the passage of the Act (Chassis, 1980).

The pressures exerted on the coastline of the UK are similar to those experienced in the USA and British Columbia. The multiple uses of the coast are documented elsewhere (see, for example, Clark, 1987). The point to be emphasized here is the continuing trend towards urban development. Also, in addition to those people living permanently on the coast, are the greater numbers of people turning to the coast for leisure and recreation. Another pattern which has emerged in the last thirty years has been the coastal locations of many new energy facilities, particularly those of the nuclear variety, which require large amounts of cooling water. Some of the other coastal issues in the UK include the development of tidal barrages, which, despite being sources of renewable energy, do create environmental impacts, and major new oil and gas terminal and pipeline projects.

RESOURCE USAGE CONFLICTS

It is against this background of competing and conflicting claims that marine aquaculture development has taken place. Table 1 illustrates some of the major resource conflicts involving aquaculture in the three countries.

With reference to marine salmon farming specifically, one of the main sources of opposition to a growing aquaculture industry, particularly on the west coasts of Canada and the USA, has been the

commercial fisheries sector. Although Anderson (1985) and others suggest that interactions between the two industries can play a valuable role in controlling over-exploitation of wild stocks, commercial fishermen are concerned about the impact of farmed salmon on the market price of wild fish. Some economists have predicted escalating competition between the two sectors with an eventual reduction in the price of salmon.

A problem which is particularly evident in British Columbia is spatial conflict with forestry and other resource extraction activities. The site requirements for successful aquaculture (sheltered, unpolluted waters) have meant that development occurs in areas valued by other interests. In the case of forestry, 95 per cent of all wood cut in coastal logging divisions enters the sea on its journey to the mills. Bays and inlets provide forestry companies with sheltered locations to dump, sort, boom and store the logs. It is often these same locations which attract fish farmers and oyster growers, and protracted legal battles. Carr (1988), for example, has documented the conflict between one of the Province's premier forest companies and an oyster company on Vancouver Island. Although sharing bays with the forest industry is possible, there are risks for the fish farmer in that some log storage activities can be harmful to the organisms being cultured. These include low dissolved oxygen levels caused by bark decomposition and direct toxicity of wood leachates.

Another source of contention in British Columbia and in parts of the US is physical obstruction caused by aquaculture facilities to fisheries and navigation, and loss of anchorage sites for recreational boats. The waters between British Columbia and Washington State, for example, constitute one of the most popular boating areas in the world and yachting enthusiasts have reported blocked access to favourite bays and public beaches (Gillespie, 1986).

A resource conflict common to all three countries has been the one between the aquaculture industry and environmental conservation organizations. This conflict has been particularly well documented on the west coast of Scotland where conservation groups have highlighted the potential pollution problems caused by fish-farming operations. In a 1990 report, the Scottish Wildlife and Countryside Link, an association of Scottish conservation bodies, highlights the potentially detrimental impacts of aquaculture on water quality, wild fish stocks, landscape aesthetics and tourism. The report concludes that a short-term economic perspective has enabled the industry to expand in Scotland at the expense of coastal ecosystems. Prominent among a number of recommendations was that a marine conservation strategy, which identifies areas which should be protected from all fish-farming development, was required for Scotland. This approach can be compared to the very positive view of the economic contribution of fish farming taken by the Highlands and Islands Development Board (HIDB). McCunn (1988) notes that the HIDB was established to assist the people of the Highlands and Islands improve their social and economic condition and to enable the region to play a more effective role in the economic and social development of the nation. By assisting the development of aquaculture, he suggests, the HIDB can attain this objective.

The emergence of large-scale aquaculture on the coasts of all three countries, then, has served to intensify conflicts between different users and uses. Doubts about the environmental sensitivity and economic viability of the industry has prompted calls for research on the long-term effects of fish-farming. It has been widely recommended that cost-benefit and impact studies be undertaken to assess the environmental, social and economic implications of aquaculture development.

Few such studies have been attempted to date. A clarification of the economic benefits is certainly needed and would enable evaluation of whether aquaculture is an economically efficient use of coastal resources. Clearly, aquaculture is seen by governments as a means of providing tangible short-term economic benefits such as employment in depressed rural areas. However, such obvious benefits have yet to be rationalized. Economic analysis has an important role to play here (Edwards, 1987):

> "Economic analysis broadly constrained can play a valuable role in this decision-making process by illuminating trade-offs among conflicting allocations of some coastal resources. Essential to this is the need to assess the outcomes and impacts of allocating resources among market and non-market forces".

COASTAL ZONE MANAGEMENT STRATEGIES

In terms of the three countries considered in this paper, two broad categories of approaches to coastal management can be identified — integrated (US) and fragmented (Canada and the UK).

The institutional and administrative arrangements for coastal management in Canada and the UK are diverse and divided. Management is characterized by single resource agencies pursuing individual goals for each resource. In Canada, the Constitution Act (1982) provides the basic allocation of rights between federal and provincial governments. The federal government is concerned mainly with fishery management and navigable waters and the provincial government with allocation of land resources, leasing of the foreshore, economic development and waste management. Nowhere, however, in the coastal zone is there a clear, undisputed basis for one government to be the sole authority (Dorcey, 1986).

The regulation of the aquaculture industry in British Columbia provides a good example of this complexity. Although one provincial government agency has been designated as the lead agency, numerous other departments from both levels of government are involved in coastal management in the province. The resources of the coast have, to a large extent, remained in public ownership and the provincial crown is the predominant owner at the land-water interface. A substantial proportion of the coast has been allocated to specific provincial resource agencies.

Applications for aquaculture licences are made to the provincial Ministry of Crown Lands operating under the authority of the Land Act. Because of the overlapping jurisdiction of other ministries to control certain aspects of aquaculture, the Ministry of Crown Lands utilizes a referral process by which details of proposed fish-farming operations are relayed to other ministries and levels of government. The provincial Ministry of Agriculture and Fisheries has been formally designated lead ministry and has responsibility for reviewing and approving fish-farm developments.

The development of aquaculture in British Columbia has been far from smooth. Amongst the problems encountered is the lengthy and complicated permit and licence structure for finfish aquaculture which imposes a time and financial cost on potential entrants to the industry. Questions have also been raised regarding the dual role of the Ministry of Crown Lands. One role is to facilitate the wise use of provincial resources. However, the Ministry also has a role to play in maximizing returns from Crown-owned resources. It has been suggested that these disparate objectives can place the government in positions of conflict of interest.

Because of concerns about negative environmental and social impacts, a moratorium was placed on the issuing of licences for finfish operations in late 1986. A Government Commission of Inquiry (Gillespie 1986) was established shortly thereafter and its final report contained a number of key recommendations, some of which have since been implemented. These included the lifting of the moratorium, the development of an aquaculture policy to clarify the roles of different government agencies and interest groups, the establishment of an aquaculture advisory council and increased government support for research into long-term impacts of the industry.

As in Canada, coastal management responsibilities in the UK are divided between a multitude of agencies. Recent studies have identified anywhere between 20 and 33 government agencies involved in managing the British coast. This plethora of agencies is reflected in a vast array of legislation applicable to the coastal zone. Various critics have argued that a combination of institutional fragmentation, the lack of a national policy and piecemeal planning has meant that the interdependence of coastal ecosystems has been ignored. Halliday (1988, 212), for example, states that "the coastline continues to be seen as a boundary, with administrative responsibilities directed either side rather than across the divide between land and sea".

As with most coastal activities in the UK, there are no national planning guidelines for fish-farming. As the territorial seabed and most of the foreshore between high and low water mark belongs to the Crown, the pivotal role of the Crown Estate Commissioners (CEC) is central to any discussion of UK aquaculture. In order to attach farm cages to the seabed, a lease from the CEC must be obtained. Usual local authority planning controls do not apply.

The dual role of the CEC has led to the body being criticized along the same lines as the Ministry of Crown Lands in British Columbia. Section 1(3) of the 1961 Crown Estate Act, states that "it is the general duty of the Commissioners to maintain and enhance the value of the Crown Estate and the return obtained from it, but with due regard to the requirements of good management". Various conservation groups (for example, Scottish Wildlife and Countryside Link, 1990) have questioned the neutrality, competence, accountability of the CEC and criticized the situation whereby the CEC are a major financial beneficiary of decisions where it is acting as an arbiter of the public interest.

The CEC attempted to counter such criticisms with the publication of aquaculture development guidelines in 1989. The need for a complete re-examination of the regulatory framework of the industry, however, resulted in a report by the House of Commons Agriculture Committee (1990). The major emphasis of this report was on planning arrangements for fish-farming and, while the Committee was satisfied that commercial profit was not an overriding factor in motivating CEC in judging lease applications, it felt that the CEC was not the ideal body to supervise fish-farming. The Committee recommended that local authorities be given a more significant planning role and that other interested parties, such as nature conservation groups, be given the right to be consulted on proposed new developments.

Just as it has in British Columbia, the growth of aquaculture in the UK has focused attention on wider issues in coastal management. The school of thought which advocates a national framework for coastal policy, or even a Department of Coastal Zone Management, has been gaining impetus. Included in a recent Countryside Commission document, for instance, is the suggestion that, at the very least, co-ordination between organizations with coastal responsibilities requires improvement and that a coherent approach to the planning and management of Britain's coastline is necessary (Countryside Commission, 1991).

In contrast to the two countries already considered, the USA has attempted to introduce an integrated approach to coastal management. In 1972, the US congress enacted the Coastal Zone Management Act (CZMA) which established a coastal management framework that encouraged states to address the aims of a national program. The overall aim of the Act was to preserve, protect, develop and restore coastal resources, and the National Oceanic and Atmospheric Administration was charged with managing the program to ensure that state coastal plans conform with criteria prescribed in the Act. Details of the Act are well covered elsewhere (see, for example, Chasis (1985), Spradley (1979)).

In order to qualify for federal funding, states were required to accomplish a number of objectives including the protection of fish, wildlife and wetlands and the encouragement of public and local government involved in coastal management decision-making. Of particular relevance to this paper was the requirement to establish comprehensive management plans for the siting of aquaculture facilities.

Rather than entering into a lengthy discussion of aquaculture, only a few recent developments will be highlighted. Tiddens (1990) discusses the gradual recognition by the federal government of the benefits of aquaculture and of the need for a National Aquaculture Act, passed in 1980. Nevertheless, Tiddens points out that federal involvement in aquaculture has produced mixed results, largely due to budgetary constraints, and that the promotion of the industry was left to individual states.

Hawaii was the first state to carry out comprehensive resource planning for aquaculture. Pursuant to this, a national resources assessment had provided detailed data on potentially suitable sites. These efforts, together with high levels of state funding and strong support from the governor's office confirmed that aquaculture is seen as an integral part of Hawaii's future (Tiddens, 1990).

While all of Hawaii's aquaculture is land-based, states such as Washington have had to deal with the challenge of ocean leasing. Washington was the first state to receive approval for funding under the CZMA. The State Department of Ecology was designated as responsible for implementing the coastal program in order to allocate the state's shore resources in a manner which was defensible on social, economic and environmental grounds (Hildreth and Johnson, 1985). Another important aspect of the Washington program, particularly as applied to aquaculture, was the use of coastal inventories which documented present uses and biophysical capabilities and enabled zoning for future uses. As in British Columbia, Washington has an aquaculture permit procedure. A key difference, however, is that all decisions are reviewed by the Department of Ecology to ensure that requirements of the state master plan for the coast are met.

The Washington aquaculture planning process has generally been regarded as a success because of its integrated and coherent approach. Responsible bureaucrats and politicians attempt to implement established goals and policies. This results in the permit approval system being predictable, a crucial factor for those considering long-term investment in aquaculture. Despite the CZMA, however, coastal management in the US has not been without problems or controversy. Chasis (1980) argues that the Act is not living up to its promise as a result of weaknesses in the statute itself and problems with federal implementation. The coastal programme came under even greater scrutiny and pressure during the 1980s as the Reagan Administration proposed removal of federal support.

Nevertheless, the CZMA has had many practical successes and is often put forward as a model for other countries to emulate. The US has also made more progress in the use of non-traditional mechanisms in order to resolve environmental conflicts. A good example is the recent Timber, Fish and Wildlife Agreement in Washington. After years of litigious struggle among forest companies, Indian tribes, natural resource management agencies and environmental groups, the 1987 TFW commits the parties to attempt to achieve the goals of all cooperating parties. These goals include wildlife and habitat preservation, and protection of fish populations and water supplies as well as the continued growth of the State's forest products industry (Halbert and Lee 1990).

CONCLUSIONS AND RECOMMENDATIONS

The recent and rapid development of aquaculture in many coastal areas, and the resultant resource usage conflicts have served to highlight the problems faced by many countries in attempting to design and implement integrated coastal zone management plans. In an attempt to undertake a preliminary investigation of the leading issues in Western countries, this study has compared the situations in the UK, Canada and the USA, countries with a recent history of aquaculture development of a similar nature under comparable economic conditions but with divergent policy and management schemes for the coastal areas. A number of important conclusions and recommendations have emerged from this study:

A. *Aquaculture-related conflicts in the coastal zone*

(i) The number of conflicts (negative interactions) are increasing as aquaculture develops (competition for space, externalities).

(ii) This can be partially attributable to inadequate government planning and coordination.

(iii) Few nations have a well-defined policy on aquaculture development.

(iv) Few environmental impact studies or economic cost-benefit analyses have been completed so precise impacts of aquaculture are not known. Although the limitations of cost-benefit analysis are well known, the technique does at least encourage the listing of all gains and losses associated with new developments and an evaluation of their relative importance.

(v) Potential impacts may include inefficient allocation of resources and loss of benefits to society. Environmental effects may include long run deleterious externalities such as alteration of the biophysical resource base.

B. *Recommendations*

(i) Countries should attempt to increase the aquaculture information base through the use of coastal inventories, environmental impact assessments and economic cost-benefit analyses.

(ii) Coastal zone management strategies should be designed using a sustainable development framework to facilitate both environmental protection and promotion of economic growth.

(iii) Countries should learn from the experiences of others, recognise the potential of aquaculture in the coastal zone economy, promote dialogue between interest groups, and encourage locally-based negotiations.

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Economic Rationality and Variability: Some Milestones for an Approach to the Strategies of Artisanal Fishing Units

by

HELENE REY
ORSTROM, Bamako, Malawi*

ABSTRACT

Fisheries economists must discuss the notion of economic rationality for the fisheries. The high degree of variability, in parameters such as resource abundance or climate, forces us to analyse the dynamic of the industry from a permanent disequilibrium perspective. Our hypothesis is that this variability helps to sharpen the rationality of decisions and behaviour. In trying to understand major differences in *rationalities*, there is scope for a more diversified design of regulation *needs* and means. The results of an economic survey was conducted by the Centre d'Etudes de Projets based on a sample of artisanal fishing units in the Mediterranean are presented here:

Three aspects relate to the limits of what are generally considered to be the economic rationality of the theory.

1. The interviews show that the fishermen make decisions according to a multi-objective function in which the maximization of profit is often secondary.
2. Confusion between the production unit management and the domestic unit decision often leads to the lack of a well identified, centralised decision centre.
3. Production externalities and difficulties in accessing information contribute to an inability to anticipate future events.

We can identify major fields in which it is possible to be more adaptable:

1. A multi-specific and multi-gear operation that often goes with high specialisation in the fishing area and marketing choices.
2. The fishing units have sources of income other than fishing.
3. Because of its family nature, the labour management shows the capacity to be flexible.
4. Flexibility based more on gear and technical reserves than on monetary reserves.
5. Short-term adaptation by a complete change of word for short periods of time, but long-term fidelity to one set of fishing techniques.

We can say that flexibility is more technical than economic. These results were obtained from a micro-economic survey. They should be extended in a global economic study that will examine the articulation among all forms of individual flexibility and test if the aggregation function of flexibilities leads to a global flexibility or rigidity.

INTRODUCTION

An economic analysis of fishing units cannot be conducted independently of a study of the dynamics and the access to the resource, which leads to a consideration of the method of production. In effect, the constraint of the availability of the resource added to its natural variability and to its unsuitable nature, determines how the production unit functions. The fishing unit therefore faces one specific source of uncertainty, in addition to the ones common to any economic activity (pathological, climatological, market and credit risks, and the availability of migrant workers in the labour force in the enclave areas). More generally, the instability and volatility of the demand function (Coriat and Boyer, 1989) and the shortening of economic trends, — while by contrast the length of production decision reversibility time has increased (Bruno, 1989), — are finding expression through an

*See Appendix for present address.

intensification of the uncertainty to which the enterprises are adapting themselves by showing more flexibility.

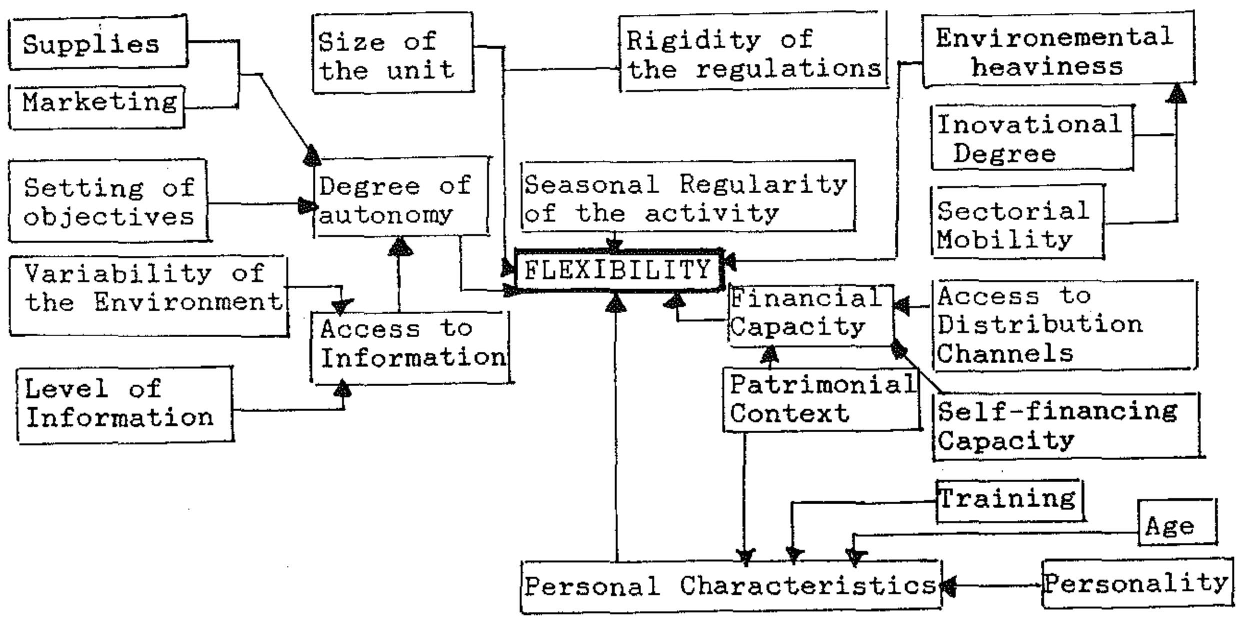
I. Individual Rationalities and Strategies of Fishing Units

The strategies that are pursued must be examined in the light of the particular existing objectives and constraints. The reasoning generally refers to the notion of opportunity cost, taking into account the objectives, and constraints, and the cost of discarding other options. The strategy must be cconsidered with regard to the desired objectives, forcing us then to state the problem of the fishermen's rationality. Allais (1953) defines the rational man as the one "who pursues objectives coherent with themselves and uses means suited to the objectives pursued". The notion of rational action comes in for a lot of criticism when the central hypothesis is examined; this concerns the maximization of the utility function under constraint, as well as to the aptitude to treat and evaluate the information for individuals. The complexity and uncertainty led to the notion of limited rationality (Lesourne, 1991) which springs from a procedural rationality, where the information acquired in making a choice is progressively integrated in order to obtain a solution which is among the best possible ones, but which is no longer necessarily the optimum solution in regard to the "real" rationality (Brochier, 1980).

The strategies adopted by the artisanal fishing units are directly influenced by their family nature and by their place in an uncertain environment (Rey, 1991). Their study must therefore be approached within the context of the problem of adjustment to the variability which defines the flexibility as an active strategy of adaptability to the uncertainty. The study of strategies presupposes that one knows the nature of the decision-maker, the types of arbitration that take place and the factors which this influence arbitration. The flexibility can be approached at the decision-making level: it is assimilable to the concept of the reversibility of the decisions. It can also be apprehended according to the degree of specialization or adaptability of the production mode. A preceding study (Garrabé and *al.*, 1990), analysed the flexibility of fishing and aquafarming units according to the question of internal or external flexibility. Here we shall take up only the general factors which affect the flexibility of the units.

Figure 1

Presentation of determining factors to the productive flexibility of units



The concept of rational artisanal fishing faces many specific restraints because of (i) the family nature of the units, (ii) the diverse objectives and (iii) the particular form of the information.

(i) The micro-economic approach to the rationality question taking the individual as an object of study, and looking at the problem of coordinating the decisions and the rationalities, is really set only in macro-economic level. This situation may seem paradoxical if one notices that the smallest national accounting reference level is the household. Studies are trying to bring to the fore the functions of family utility more or less related to the functions of the individual utility of the household members (Bourguignon, 1984). At the level of the productive functioning, the family nature also introduces a further complexity owing to its subdivision into two interdependent subsystems : the system of production and the family group. In consequence, this has some special effects on decision making. The main question then is the degree of dependency between the unit of production, the residence, the consumption, and the accumulation. The family chief holding generally holds the decision-making power in the production unit, but one frequently notices a confusion between the objectives of the family and those of the production unit. In extreme cases the production unit is justified only as a means permitting the family reproduction.

(ii) The artisanal fishing unit pursues a range of objectives which are not always apprehended when it comes to optimality. The operator can be more sensitive to security than to rentability. In developing countries, the security objective is often related to food but it can be extended either to the accounts, implying strategies to minimize expenditure, or to marketing when the productive choices are influenced by the degree to which the marketing channels are mastered. The security can finally mean a patrimonial means of keeping some property or usage rights. The artisanal fisherman pursues different objectives among which the main ones are[1]:

- —To enhance his social status in the fishing community to which he belongs, this enhancement being carried out according to parameters characteristic to the environment. Among these, are the expertise, the equipment level (which implies minetic behaviours), but also a multitude of subjective criteria which cannot be limited to the concept of economic profit.
- —The search for autonomy, associated with freedom with regard to the socio-economic context; the constraints of the natural conditions even though very important do not present the same liberty-depriving characteristic as the economic or institutional constraint does. This search for autonomy can lead to tax evasion, but can also be the origin of particular technical or commercial choices, or explain some strategies of integration upstream or below.
- —The minimization of labour time (which is closely akin to the symbols of liberty previously evoked) in connection with the definition of a sufficient revenue level in regard to his needs.
- —The desire for status in the community and place of origin can make activity continue at the break-even point. In effect, during stagnation or in a period of restrictive regulation of the market, the pursuit of the activity, or even in the long run, remonstrations by the family may constitute the only way of preserving the productive capital.

(iii) The non-appropriation of the resource is externality producing. No single operator has direct control over his own level of production. The average production of each operator is determined by the interaction between the size of stocks and the aggregation of individual decisions (Gilly, 1989). These factors reinforce the difficulties for the fishermen to anticipate, all the more so since, for the artisanal fishing, the arbitration between the gears can be daily ones and that many gears do not have a specific vocation. The dissemination of the information is proof of the transparency degrees of different sectors. This differentiated access to information is the result of the non-appropriation and the determining factor of the know-how which is the main condition of access to the resource from a technical as well from a social point of view. The key concept of the balancing of fisheries (in Perroux's traditional meaning) which explains some intergroup or even intragroup behaviours is therefore the informational assymmetry.

II. Artisanal Fishing units have strategies directed at short-term flexibility

We shall not tackle the different finalities which intervene in an interdependent way into "the functions of objectives" of the units. Nor shall we take into account the strategies of "*status quo*" which characterize notably the units of restricted production. We shall limit our inquiry to the inventory of adaptation forms, put into use in the case of the artisanal fishing in order to test the hypothesis of the existence of a flexibility strategy, and try to assess the degree of flexibility of the units.

The observations are based on the results of a study conducted by the Centre d'Etudes de Projets on the small-scale fisheries in Languedoc-Roussillon[2], and on our knowledge of artisanal fishing in the Mediterranean.

The flexibility will be considered in connection with the intra- or inter-annual fluctuations of the resource. Other factors of uncertainty, notably price variations — will not be examined here. The results of the survey confirm the importance of the variability with which these units are confronted: at the intra-annual level, two-thirds of the fishermen mention a seasonal concentration of very important catches while 75% notice very strong inter-annual variations in the volume of their catches.

Diversification, the recourse to family labour and overinvestment are the most noticeable forms of flexibility.

(i) Diversification and multiple activities are traditionally some of the privileged forms of adaptation and risk reduction. Thus, the multifunctional nature of the artisanal fishing unit enables it to adapt to the varied conditions of the environment (Laloe and Samba, 1990). In the Mediterranean area, the small scale fishing units practice several kinds of fishing during the year (an average of three and in extreme cases fifteen). Only 13% of units are specialized (restricted to a single method of fishing). The correlation between the positive growth of the level of income and the number of fishing techniques testifies to the stabilizing role of non-specialization strategies.

(ii) Diversification extends to include some non-fishing activities for 39% of the units. Only 25% of the fishermen's wives have an activity outside the unit. The multiple activities of the operator may constitute a counter-risk currency stock and/or an income contribution which increases the unit's financial capacity. Thus, at the level of Mediterranean small scale fisheries for example, the incidence of fishermen's wives undertaking an external activity is dependent on the size of the unit and on the recourse to borrowing. We can conclude that the external income either helps to finance investments or serves as a guarantee for a loan[3].

(iii) The family nature of the labour force is a flexibility factor[4] because it offers a perfect divisibility which enables an adaptation to the variations of the activity. Furthermore Platteau (1989), considering the irregular nature of the activity, minimizes the risks of under-use of the equipment, the recruiting inside the family ensuring their availability due to the privileged relation which connects them to the unit. Only 20% of the Mediterranean small-scale fisheries employ outside labour[5]. In all the cases, the units employing crewmen do not have recourse to family labour, a fact having the tendency to indicate an opposition of strategies at the level of the labour force. Only 15% of the units are characterized by a stable family association (usually father and son). In other cases, the contribution of family labour is of a more desultory nature inherent in the flexibility of the unit; wives participate in fishing activity in 57% of the units whilst in 28% other members of the family do so as well. The contribution of family labour is slightly more important for the units that make direct sales. However, it remains of secondary importance, in 70% of cases never exceeding eight hours a week.

(iv) The availability of equipment of which the volume is largely surplus to current needs does not result only from constraints of the turnover of the equipment. It seems that there may be a voluntary strategy of stocking designed to seize possible opportunities. In this way, the artisanal fishermen in the Mediteranean utilise their gear an average of only 27% of the time in the case of meshed fishing nets, 32% with trammel nets, and 27% with *capechades.*

III. Constraints inducing a rigidity

The stability of the means of production, its dependency on the physical context, the lack of financial capacity and the specialization of commercial channels restrict the units flexibility.

(i) The flexibility of the units seems very weak in the medium-term. In effect, 76% of the fishermen never changed their type of fishing and 72% never moved from their fishing grounds during their career. One finds some periods of discontinuity in the activity[6] which tend to show that the adapation could have been achieved by a change in type of activity, the fishermen switching themselves over to another activity (18% of the population) or re-embarking as crewmen for a period of time (29%).[7] The hereditary nature of the sector finds expression in weak sectorial mobility: only 35% of the fishermen have had another job before becoming fishermen, and only 12% have been bosses outside the context of small scale fisheries.

(ii) A relative specialization of the fishing areas[8] which restricts the units' flexibility is apparent, 58% being specialized as regards the type of fishing grounds exploited (exclusively sea-fishing or lagoon-fishing), while the fishermen who undertake mixed fishing (lagoon and sea) generally have a dominant area and a distribution of activity between the areas which remain stable from one year to another (63%).

Several things explain the absence of geographical mobility. There is a close correlation between know-how and the area fished due to the importance of knowledge related to environmental data. Apart from the vessels fishing at the edge of the continental plateau, the low power of the engines (65 horsepower in average) limits fishing to the nearest fishing grounds (only 16% of the fishermen go further than six miles). Hence the need to reach the fishing grounds quickly is cited by one-third of the fishermen as the determining factor in the choice of their engine's horsepower. Moreover, their mobility is limited because they cannot fish in a different jurisdiction. Fishermen can gain access to fishing grounds that are not under the control of their own jurisdisction only with the other jurisdiction's authorization. This constraint is very restrictive in the case of lagoon-fishing, and the access to natural beds of wild shellfish, and is often the cause of major conflicts. Thus, 54% of the fishermen have never crossed over the territorial boundaries of their jurisdiction during their whole career. Furthermore 80% of the fishermen actually live in the same town in which they were born or in a town less than 20 km from their birthplace.

(iii) Intra-annual fluctuations are shown by some shortages of funds for 62% at the level of the fishermen. There seems to be no specific answer at the production level but rather the family needs to adapt to the unit's cycle of activity. In effect, most of the fishermen say that they defer their expenses and make informal provision when they collect their receipts. The practice of a complementary activity, or of an external activity on the part of the wife, are also cited, while the most current short-term method of adaptation is to suspend the payment of social insurance which is seen to be the unit's main burden. Thus, 25% of the fishermen declare that they do not systematically 'disembark' when they do not sail out, while their movements as they have been registered by Maritime Affairs show that on average the maximum length of embarkation without discontinuity is four months.

In the same way three quarter's of the fishermen face major fluctuations in their catches from one year to the next. Only one-third anticipate these fluctuations by building up currency stocks. The survey did not test whether the absence of stocks is because thay are unable to accrue this revenue or from alternative allotments. While fishermen most often mention difficulties resulting from the fact that their level of revenue is only enough to maintain the current functioning of the unit, the observed practices tend to suggest the existence of alternative allotments.

Only half of the fishermen have recourse to loans. The weak level of investment (for 52% of the fishermen, the total of their gross assets — boat, engine, sailing material — is less than 50,000 francs), the wish for autonomy and the absence of development projects explain the importance of self-financing. The level of the initial capital is dependent on the individual family. Family loans play a small role as an alternative to institutional financing. The recourse to family loans affects only 10% of the fishermen.

(iv) The study of commercial practices seems to show a lack of flexibility. Only 27% of the fishermen take advantage of the competition between wholesalers while 70% of the fishermen have only one channel and only 9% do not have a dominant channel. The share in direct marketing is globally very weak since it affects only 30% of the units. One notices a correlation between the types of fishing indicating that direct sales are mainly carried out by the maritime units that specialize in the catching of fish. This situation can be explained in the case of the fishery examined here by the importance of species like congers and clams which are the concern of specific specialized channels and which enjoy remunerative prices. The studies conducted by biologists (Farrugio and Le Corre, 1985) confirm the importance of the wholesalers for lagoon fishings since they sell 73% of the catches.

CONCLUSION: FLEXIBILITY OF FISHERIES

The equilibrium concept at fishery level presupposes a general cohesion of action in time and space which sets the problem of analysing the objectives, means and agents 9 of the regulation. The flexibility of the fisheries as a whole should be analysed. Attempts to model the fisheries come up against problem of coordination and mutual compatibility of the operators' activities which guarantees the activities' collective coherence. The bio-economic models depend on postulating a single centre of decision controlling all the decisions of the fishery (Weber and Meuriot, 1984). Here one finds the limits of the concept of collective anticipation, and moreso since the unsuitable nature of the resource leads to a situation of non-cooperation which refers back to the economic problems of multiple equilibrium (Mongin, 1984). The question of flexibility must be considered at a macro-economic level since some studies (Bruno, 1989) reveal that the aggregation of individual flexibilities leads to rigidity in the global situation. All the same, at the inshore marine level, Allen and McGlade(1986) show that individual responses can intensify the fluctuations of the recruitment.

NOTES

1. These objectives are not listed in order of their importance.
2. This study was conducted by the Centre d'Etudes de Projets acting on a request from the Ministry of the Sea (Rey, 1989). It concerned a representative sample of 198 fishermen on a stratified polling basis according to the geographic locality, the rate of embarkation and membership of the co-operative of the "cinq ports" for the fishermen of Thau lagoon. The following people took part in this study : M. H. Dabat, N. Daures, N. Gaudin, M. Garrabe, B. Heyer, D. Houdayer and L. Pons.
3. The contribution of external revenue also makes it possible to get round the rentability and in this way to introduce criteria of choice going beyond the purely economic aspects.
4. Conversely the family nature can be a rigidity factor when the development of the business is dependent on the size of the labour force. The growth of the labour force according to the age of the family members sometimes explains the succession of the phases of growth and decline of a business (Jorion and Delbos, 1984). When the labour force is made up of crewmen, it can become a permanent cost since the subsistence of the family members/must be ensured (Badouin, 1987).
5. Actually 49% of the units employ crewmen, but in 40% of the cases it is a fictitious embarkation, enabling the seaman (sometimes a member of the family) to undertake the 36 months of mandatory sailing in order to get himself registered as a skipper.
6. We have assumed that there was a discontinuity when the fishing ceased for 6 months.
7. In some ports, notably those where tuna boats are present, this strategy of skipper alternating/crewman is practiced according to the cycle of the activity of tuna boats.
8. It would be proper to distinguish the fishing area, which corresponds to a type of environment, from the fishing grounds, which represent the precise location where the fishing takes place. Apart from those with fixed gears or in the case of some natural beds of wild shellfish, the units did not frequent special fishing grounds.
9. Besides the customary forms of regulation, which come under the institutions of "prud'homies" jurisdictions, Mediterranean artisanal fishing is self-regulated. Professionals often initiate the measures taken by the administration (Meuriot and Dreumiere, 1986) and some spontaneous initiatives have been noticed between fishermen sharing the same gear.

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Appendix

Current Addresses of authors

Denis Bailly
OÏKOS
91 Rue de Saint-Brieuc
35000 Rennes
France
Tel: 33 99 33 00 85
Fax: 33 99 33 14 34

Jean-Pierre Boude
Ecole Nationale Superieure Agronomique de Rennes (ENSAR)
Department Halieutique
65 de Saint-Brieuc
35042 Rennes Cedex
France
Tel: 33 99 28 75 30
Fax: 33 99 28 75 35

Marie-Hélène M. Dabat
Centre d'Etudes de Projets (CEP)
14 rue Cardinal de Carbrires
34000 Montpelier
France
Tel: 33 67 60 49 90
Fax: 33 67 60 42 31

Ásgeir Danielsson
National Economic Institute
Kalkofnsvegi 1
150 Reykjavik
Iceland
Tel: 354 1 699523
Fax: 354 1 626540

Wim P. Davidse
Agricultural Economics Research Institute (LEI)
Conradkade 175
2517 CL Den Haag
Netherlands
Tel: 31 70 614161
Fax: 31 70 615624

Jan Willem de Wilde
Agricultural Economics Research Institute (LEI)
P.O Box 29703
2502 LS Den Haag
Netherlands
Tel: 31 70 614161
Fax: 31 70 615624

Ramon Franquesa
Facultat d'Economiques
University of Barcelona
Av. Diagonal 690
Barcelona 08034
Spain
Tel: 34 3 428 52 72
Fax: 34 3 203 8307

Hans Frost
Danish Institute of Fisheries Economics Research (DIFER)
University of South Jutland
Nils Bohr Vej 9
6700EsbjergØ
Denmark
Tel: 45 79 141111
Fax: 45 79 14 1199

Michel J. Garrabé
Centre d'Etudes de Projets (CEP)
14 rue Cardinal de Carbrières
34000 Montpelier
France
Tel: 33 67 60 49 90
Fax: 33 67 60 42 31

Patrice A Guillotreau
Centre for Marine Resource Economics (CEMARE)
University of Portsmouth
Locksway Road, Milton
PO4 8JF Portsmouth
United Kingdom
Tel: 44 705 827681
Fax: 44 705 844037

Thorkell Helgason
Ministries of Industry and Commerce
Arnarhvoll
150 Reykjavik
Iceland
Tel: 354 1 609070
Fax: 354 1 621289

J. Paul Hillis
Department of the Marine
Fisheries Research Centre
Abbotstown
Castleknock
Dublin 15
Ireland
Tel: 353 1 8210111
Fax: 353 1 8205708

Chris Ioannidis
Cardiff Business School
University of Wales, College of Cardiff
(UWCC)
Cardiff CFl 3EU
United Kingdom
Tel: 44 222 874000 ext 5190
Fax: 44 222 874419

John O.S. Kennedy
La Trobe University
Bundoora, Victoria 3083
Australia
Tel: 61 03 479 2313
Fax: 61 03 471 0592

Ólafur Ørn Klemensson
Central Bank of Iceland
150 Reykjavik
Iceland
Tel: 354 1 699824
Fax: 354 1 699603

Frederick Lantz
IFREMER
155 Rue J.J. Rousseau
Issy les Moulineaux 92138 Cedex
France
Tel: 33 46 48 22 67
Fax: 33 46 48 22 76

Raphael Lostado
Facultat de Economicas
University of Valencia
Ave. Blasco Ibanez 30
Valencia 46010
Spain
Tel: 34 6 3864562
Fax: 34 6 3864404

Arthur Neiland
Centre for Marine Resource Economics
(CEMARE)
University of Portsmouth
Locksway Road, Milton
PO4 8JF Portsmouth
United Kingdom
Tel: 44 705 827681
Fax: 44 705 844037

David E Nowell
Dept. of Geography
University of Portsmouth
Locksway Road, Milton
PO4 8JF Portsmouth
United Kingdom
Tel: 44 705 827681
Fax: 44 705 844037

Chris Reid
Centre for Marine Resource Economics
(CEMARE)
University of Portsmouth
Locksway Road, Milton
PO4 8JF Portsmouth
United Kingdom
Tel: 44 705 827681
Fax: 44 705 844037

Hélène S. Rey
IFREMER
155 Rue J.J. Rousseau
Issy les Moulineaux 92138 Cedex
France
Tel: 33 46 48 22 67
Fax: 33 46 48 22 76

Pavel Salz
Agricultural Economics Research
Institute (LEI)
P.O. Box 29703
2502 LS Den Haag
Netherlands
Tel: 31 70 3614161
Fax: 31 70 3615624

Massimo Spagnolo
IREPA
Via Benedetto Croce 35
84100 Salerno
Italy
Tel: 39 89 241503
Fax: 39 89 241145

Susan Shaw
Department of Marketing
Strathclyde Business School
University of Strathclyde
Stenhouse Building
173 Cathedral Street
Glasgow G4 0RQ
Scotland
United Kingdom.
Tel: 44 41 552 4400
Fax: 44 41 552 2802

Niels Vestergaard
Danish Institute of Fisheries Economics
Research (DIFER)
University of South Jutland
Nils Bohr Vej 9
6700 Esbjerg Ø
Denmark
Tel: 45 79 141111
Fax: 45 79 14 1199

Stein W. Wallace
Department of Managerial Economics and
Operations Research
Norwegian Institute of Technology
University of Trondheim
N-7034 Trondheim
Norway
Tel: 47 73 593 609
Fax: 47 73 593 603

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